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A REVIEW OF THE INSECTICIDAL USES OF ROTENONE AND ROTENOIDS FROM DERRIS, LONCHOCARPUS (CUBE AND TIMBO), TEPHROSIA, AND RELATED PLANTS

PART III. HOMOPTERA

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INTRODUCTION

This is the third in a series of papers designed to review all available information on the insecticidal uses of rotenone and the rotenoids. Part I reviewed tests with Derris, cube, timbo, Tephrosia, Mundulea, and their constituents on members of the orders Collembola, Orthoptera, Dermaptera, Odonata, Isoptera, Corrodentia, and Mallophaga. Apparently no tests with the rotenone plants on Thysanura, Ephemeroptera, or Plecoptera have been recorded. Part II reviewed the tests made on Thysanoptera. Part III, the present paper, reviews the tests on Homoptera.

HOMOPTERA

Aleyrodidae

Dialeurodes chittendeni Laing, a rhododendron whitefly

Wilson (309) in 1929 reported that sprays containing nicotine and derris were found to be less toxic than a 2-percent oil spray to nymphs of this whitefly infesting leaves of Rhododendron jacksoni and R. ponticum in England.

Dialeurodes citri (Ashm.), the citrus whitefly

Cube extract in oil, emulsified in water with powdered milk (cube extract 1:75,000, oil 0.33 percent), killed 97.4 percent of the larvae, as compared with 79.9 percent killed by the check oil; of the eggs 23.6 percent were killed by cube extract in oil (cube extract 1:50,000, oil 0.5 percent), as compared with 10.5 percent by the check oil. --Turner (271) in 1932.

The Alabama Polytechnic Institute (4) in 1938 reported on the effectiveness of derris powder with various carriers against the citrus whitefly. In experiments with powdered derris added to soaps, sulfated alcohols, sulfonated castor oil, sodium salts of alkylated aryl compounds, oil emulsions, and other materials, the dilute oil emulsions (0.5 and 1.0 percent) formed more effective combinations with derris than the more specific wetting agents. The effectiveness of derris was depressed in both acid and alkaline wetting media, and in liquid lime sulfur. With soap, derris was more effective than nicotine sulfate and organic thiocyanate sprays.

Anderson and Walker (9) in 1939 reported on the control of whiteflies on gardenias. Immature stages of the citrus whitefly on a tropical hibiscus plant in an 8-inch flowerpot in the Virginia Truck Experiment Station greenhouse were not controlled by dips of nicotine sulfate plus soap or Lethane 440. When the leaves of this hibiscus plant were heavily infested with all stages of the whitefly and some of the leaves were turning yellow, one-half of the plant was dipped for 30 seconds in a solution containing 1 percent of a 60 percent Stantex Dispersing Oil (a mineral oil containing a small percentage of oleic acid and a certain spreader) and 40 percent of a derris extract in camphor-sassafras base oil containing 5 gm. of rotenone in 100 cc., 1 percent of liquid Red "A" Soap (containing 40 percent of dry soap) and 98 percent of water. The

other half of the plant was dipped for a similar length of time in a 1-percent mixture of 80 percent of Pyrolene M. P. (a sodium salt of a synthetic wax prepared from a vegetable base) and 20 percent of the derris extract described above.

Both treatments gave 100-percent control of all stages, except for a few adult whiteflies that escaped before the plant was submerged. The plant suffered no apparent ill effects from the treatments and within a few weeks the dead bodies and cast skins of the whiteflies came off the leaves, and the plant was restored to a normal thrifty condition. Tests are also recorded with Stantex R (80 percent of Stantex Dispersing Oil and 20 percent of derris extract in camphor-sassafras base oil containing 5 gm. of rotenone per 100 cc.). The citrus whitefly was satisfactorily controlled on gardenias by thoroughly spraying with 1- and 2-percent solutions of Stantex R emulsified with soap.

Trialeurodes vaporariorum (Westw.), the greenhouse whitefly

Davidson (63, 64) in 1930 made careful tests in a greenhouse with pure rotenone, racemic deguelin, tephrosin, and toxicarol. These were suspended in water by adding an acetone solution of each to water without the addition of a wetter or spreader. Results were as follows:

Insecticide	Concentration (gm. : cc.)	Mortality of whitefly stages		
		Eggs	Larvae	Pupae
		Percent	Percent	Percent
Rotenone	1:250	--	--	0
Do	1:2,000	99.1	--	--
Do	1:20,000	82.0	--	--
Do	1:30,000	--	94.9	--
Do	1:60,000	--	88.8	--
Do	1:100,000	9.6	94.7	--
Racemic deguelin	1:30,000	--	23.0	--
Tephrosin	1:20,000	14.0	--	--
Toxicarol	1:500	25.0	--	--

Tiburec and Blattny (268) in 1939 reported that in experiments with the greenhouse whitefly all the adults were dead in 30 to 38 minutes after being dusted with a powder of derris and pyrethrum mixed with chloropicrin at the rate of 3 cc. per 1000 grams. The whiteflies became very active before they died, which indicated that chloropicrin itself does not possess any particular insecticidal property but, by accelerating the metabolic processes in the insects, renders them more susceptible to the toxic effects of other substances.

Aleyrodidae (unidentified species)

Davis (66) in 1932 stated that with penetrating miscible oils derris has proved very effective against whiteflies.

Species of Aleyrodes are not affected by derris. --Van der Laan (178) in 1936; also de Bussy et al. (31).

Etablissements Rotenia in 1938 reported in a letter to R. C. Roark that Trialeurodes sp. on tomatoes in hothouses was killed by a proprietary dust containing 12 percent of cube having a 6 percent rotenone content.

Aphiidae

Anuraphis cardui (L.), the thistle aphid

Neoton (derris extract in fish oil) 112.5 gm. plus twice its weight of soap killed 100 percent. --Institute of Physical and Chemical Research (162) in 1927.

Anuraphis maidi-radicis (Forbes), the corn root aphid

The South Carolina Agricultural Experiment Station (249) in its annual report for 1937 reported that cotton root aphids caused great damage in the Coastal Plains area of South Carolina. Three species of aphids are usually present. Named in the order of their abundance these are A. maidi-radicis, Trifidaphis phaseoli (Pass.), and Rhopalosiphum sp. [probably R. subterraneum Mason].

The most practical approach toward controlling these root aphids appears to be in mixing some insecticide or repellent with the fertilizer and applying the mixture directly to the soil. With this in view, 36 plots were laid out in each of 4 fields, and each field, or experiment, was treated with 6 different insecticides replicated 6 times. One of the insecticides was derris powder (4 percent rotenone) applied at the rate of 80 pounds per acre. Each insecticide was thoroughly mixed with the fertilizer and applied to the soil prior to planting. Counts were then made of the number of aphid colonies present on 100 linear feet in each plot after the cotton came up, also of the total number of plants that came up on 100 linear feet in each plot, and later of the number that were living just before chopping or thinning. The percentage of reduction in stand was then computed for each treatment. At the end of the fruiting period, when all the bolls were set, counts were made of all the bolls present on the two center rows in each plot. No significant differences between any of the treatments appeared in the number of aphid colonies, in the percentage reduction in stand, or in the boll counts. No harmful or undesirable effects were noted in the growth of the plants from the use of any of these insecticides when applied to the soil in the amounts stated.

Tests conducted against the root aphids T. phaseoli, R. subterraneum, and A. maidi-radicis on cotton were reported in June 1938 by Rainwater (228). In the first series of experiments derris was mixed in the soil of the seedbed from 2 to 3 weeks before planting, at the rate of 100 pounds per acre. The seed came up to a good stand. On the derris-treated plots 2.5 colonies per 100 row feet were present, in comparison with 7.5 and 10.5 in the checks. In another series of tests, conducted in a field where the cotton had been killed by the aphids and it was necessary to replant, the materials were lightly mixed with the soil and the seed was

immediately planted. Two hundred pounds of tobacco dust, to which 0.25 percent of rotenone from derris powder had been added, was used per acre. The tobacco-derris plot came up to a good stand. In the third series of tests 1.6 pounds of derris was mixed with 100 pounds of cotton seed just before planting. The seed treated with derris germinated more quickly and was up 24 hours earlier than the checks. There was very little reduction in the number of aphid colonies.

Anuraphis persicae-niger (Smith), the black peach aphid

In the field the mortality of this species when sprayed with a suspension of pure rotenone in water, 1:40,000, was 98.3 percent. --Davidson (63) in 1930.

Anuraphis roseus Baker, the rosy apple aphid

The New York Agricultural Experiment Station (211) in 1928 reported that rosy aphid infestation of apple trees was noticeably reduced by Derrisol. Van Buren (307) in 1928 reported Derrisol to be effective. Parrott got about 8 percent of the rosy aphids on Rome trees when Derrisol at 1:800 was used, as compared with a little less than 1 percent on plats sprayed with lime-sulfur and nicotine sulfate. In the field the mortality of this insect when sprayed with a suspension of pure rotenone in water was 96.3 percent at a concentration of 1:40,000 and 90.2 percent at a concentration of 1:60,000. --Davidson (63) in 1930.

Parrott and Glasgow (220) in 1930 reported trials of different insecticides against the rosy aphid in New York. The results with the derris preparation, Derrisol, were as follows:

Insecticide	Aphid-attacked apples per tree Percent
Lime-sulphur 1:40 + Derrisol 1:800	22.17
Lime-sulphur 1:40 + Derrisol 1:1600 + nicotine sulphate 1:1600	7.39
Bordeaux 4-4-50 + Derrisol 1:800	43.90
Check plot	51.65

In past seasons samples of Derrisol, although consistently inferior to nicotine sprays, greatly reduced the aphid population.

Both rotenone and derris extract proved much more toxic than pyrethrum extract to this species (cf. Aphis pomi Deg.). The tests were made by dipping apple twigs infested with these aphids in solutions of various concentrations. --Ginsburg and Schmitt (125) in 1932.

Anuraphis tulipae (Fonsc.), the tulip bulb aphid

Dusting the bulbs with derris is effective in controlling infestations of the tulip aphid. --Wilson (309) in 1938.

Aphis gossypii Glov., the cotton aphid, or melon aphid

McIndoo et al. (189) in 1919 reported that the alcoholic extract

from Derris elliptica roots in the ratio of 1 pound of roots to 200 gallons of water plus 4 pounds of fish-oil soap killed 100 percent of this aphid in laboratory tests. Extracts of several species of Derris were tested, as well as a derris dust which killed 99 percent.

Dennis (73, 74) in United States Patent 1,621,240, issued March 15, 1927, and in Reissue 18,667, issued November 22, 1932, stated that an alcoholic extract of cube is eight times as effective as similar derris extract and is also slightly more effective than nicotine sulfate when sprayed on the cotton aphid.

When A. gossypii on celery in a greenhouse was dusted with a mixture of 2 parts of rotenone and 98 parts of diatomaceous earth, 68.9 percent were killed. --Davidson (63) in 1930.

Little (183) in 1931 gave a detailed account of the insecticidal properties of devil's-shoestring (Tephrosia virginiana). Dried and powdered (100-mesh) roots were suspended in water and tested against many kinds of insects. When sprayed on A. gossypii at a dilution of 1:3,200 without spreader, devil's-shoestring gave a kill of 64.3 percent, as compared with 82.8 percent for nicotine sulfate and 73.1 percent for derris.

Field tests by Little (182) with A. gossypii showed that devil's-shoestring has considerable promise as a contact spray.

This insect is easily controlled by spraying with Derrisol at 1:800 or Katakilla at 5 pounds per 100 imperial gallons. --Andries (10) in 1932.

Goff and Tissot (129) in 1932 reported that the melon aphid may be controlled by treating the infested plants with one of the liquid aphicides containing extracts of nicotine, pyrethrum, or derris.

Merino and Otanes (197) in 1937 recommended a derris-soap spray for the control of this species on cotton in the Philippine Islands.

Wille, Ocampo, Weberbauer, and Schofield (307) of the Agricultural Experiment Station at Molina, Peru, in 1937 reported that sprays of cube extract containing 0.05 or 0.01 percent of rotenone proved as effective against this species as a 0.5-percent solution of nicotine sulfate.

Gunderson (134) in 1938 recommended the use of derris against melon aphids.

Gaines (114) in 1939 reported the tests of derris or cube added to fluorine compounds and applied as dusts.

Treatment	Relative aphid population
Calcium arsenate	100
Synthetic cryolite alone	100
Synthetic cryolite + derris (0.5 percent rotenone)	14
Barium fluosilicate alone	103
Barium fluosilicate + derris (0.5 percent rotenone)	23

When derris or cube was added to calcium arsenate, in no case did a damaging aphid population develop; however, at Tallulah a dust containing rotenone 0.6 percent, Avirol 1 percent, water 1 percent, and peanut oil 0.5-percent, with talc as a carrier, applied after the infestations became heavy, failed to give satisfactory control. The heavy infestations were satisfactorily controlled with one application of lime and nicotine sulfate containing 3 percent of nicotine.

Haude (144) in 1939 wrote that there is considerable unpublished evidence indicating that the cotton aphid may be effectively held in check with rotenone-bearing dusts.

Tiburec and Blattny (268) in 1939 reported that in tests with A. gossypii a dust of derris and chloropicrin (3 cc. chloropicrin per 1,000 gm. of derris powder) proved as ineffective as a dust of derris alone.

The United States Department of Agriculture, Bureau of Entomology and Plant Quarantine (284) in 1938 reported good control of cotton aphids at Florence, S. C., with the following rotenone dusts: 11.2 pounds of derris-tobacco-sulfur dust (1 percent rotenone) per acre; and 18.4 pounds of cube-sulfur dust (1 percent rotenone) per acre. From these and other observations it appears that rotenone may be more effective in the presence of moisture. At Tallulah, La., three plots with a medium aphid infestation were dusted by M. T. Young with a derris-clay mixture containing 1 percent of rotenone at a rate of 10 to 13 pounds per acre. To one of the mixtures was added 1 percent of Aresket, to another 1 percent of Vatsol, while the third contained no wetting agent. Very little, if any, control was obtained from any of these applications. Another series of heavily infested plats at Tallulah was dusted by G. L. Smith with these mixtures about the same time, also with negative results. Similar lack of control of cotton aphids with dusts containing rotenone resulted on plots dusted by K. P. Ewing at Port Lavaca, Tex., in July.

Aphis helianthi Mon.

McIndoo, Sievers, and Abbott (189) in 1919 reported that 96.6 percent of these aphids were killed when sprayed with derris powder soaked for half an hour in soap solution consisting of 1 pound of powder to 100 gallons of water plus 2 pounds of fish-oil soap.

Aphis illinoisensis Shim., the grapevine aphid

Dickey and Loucks (80) in 1938 recommended derris spray for the control of (Macrosiphum) Aphis illinoisensis Shim. attacking grapes in Florida.

Aphis medicaginis Koch, the cowpea aphid

Castillo (48) in 1926 reported the results of studies on the insecticidal properties of three species of Derris growing in the Philippines, namely, D. polyantha Perk., D. philippinensis Merr., and D. elliptica (Roxb.) Benth. The roots were cut into thin, transverse slices and dried in an oven at 40° C. until the weight remained fairly constant. The dried material was then comminuted in a mortar and the

powdering finally completed in a meat grinder. The fine powder was separated from the fibers by sifting through fine-meshed cloth. In the comparative studies of the effect of various concentrations, D. philippinensis was used because it was relatively more abundant, hence more easily procurable, than the others. Tests were made on mosquito larvae and on A. medicaginis. The concentration of D. philippinensis which brought about the largest number of deaths of aphids was much higher than that required for mosquito larvae, namely, 4:1,000. The lowest concentration of D. philippinensis used, 0.5:1,000, caused a noticeable percentage of mortality among aphids, as compared with the control.

Gaines (114) in 1939 reported tests against A. medicaginis of derris or cube added to fluorine compounds and applied as dusts (see discussion under A. gossypii, p. 6).

Aphis nerii Fonsc.

A commercial derris extract at 1:500 gave 13 percent control. -- DeOng and White (76) in 1924.

Aphis odinae (van der Goot)

The Mysore, India, Department of Agriculture (203) in 1938 reported suspensions and alcoholic extracts of derris to be effective against this species.

Aphis papaveris F.

Establissements Rotenia in 1938, in a letter to R. C. Roark, stated that this species on cherry trees is killed by a proprietary dust containing 12 percent of cube of 6 percent rotenone content.

Aphis pomi Deg., the apple aphid, or green apple aphid

McIndoo, Sievers, and Abbott (189) in 1919 reported that derris powder used as a dust under practical conditions was effective against green apple aphids.

Kelsall et al. (169) in 1926 reported that against the green apple aphid derris, 5 pounds in 100 imperial gallons of water, without soap, gave practically complete control, being a little superior to 1 pound of nicotine sulfate (40 percent). With the addition of a little soap to the solution, derris as low as 2-1/2 pounds to 100 imperial gallons of water gave 100-percent mortality, and is superior to 1 pound of nicotine sulfate (40 percent). A dust containing as high as 20 percent of derris plus 80 percent of hydrated lime proved ineffective against the green apple aphid when applied to dry foliage. Derris dust requires moisture to make its toxic properties effective against this aphid.

Cutright (60) in 1930 reported that Derrisol was the best of the derris products tried against apple aphids. The efficacy of lime-sulfur or oil sprays against aphid eggs was but little improved by the addition of Derrisol. At 1:800 Derrisol satisfactorily killed aphids if they were thoroughly wetted.

In the field 99 percent of the apple aphids were killed when sprayed with a suspension of rotenone 1:60,000; and 77.2 percent were killed by a dust containing 1 part of rotenone and 99 parts of diatomaceous earth. --Davidson (63) in 1930. Fulmer (113) in 1930 wrote that the green apple aphid can be effectively controlled by spraying with derris powder, 5 pounds per 100 imperial gallons.

Ginsburg and Schmitt (125) in 1932 compared the contact insecticidal action of rotenone and the pyrethrins on apple aphids. Apple twigs infested with these aphids were dipped in solutions of various concentrations of rotenone, derris, and pyrethrum extracts. Both rotenone and derris extract proved much more toxic to aphids than did pyrethrum extract. Rotenone at 1:10,000 killed 93.4 percent of the apple aphids in 24 hours; derris extract (rotenone equivalent to 1:13,200) killed 93 percent.

Ginsburg and Granett (122, 123) in 1934 tested on the green apple aphid untreated derris powder and also the marc after extraction with acetone or with acetone followed by water. The materials were applied in the form of coarsely and finely ground dusts. Derris-root dust (rotenone 4.1 percent) was more toxic against aphids when applied on wet than on dry foliage. Residues from derris root extracted with acetone possess practically no toxicity to aphids. In 1935 the same workers (124) studied the compatibility of derris in combination with other materials in tests on A. pomi. The addition of lime, lead arsenate, or sulfur, singly or combined, tended to reduce the aphicidal properties. It also appeared that with a good wetting agent a suspension of fine derris root was as efficient as a dispersion of a commercial acetone extract. Liquid lime-sulfur appeared to exert a deleterious effect on the aphicidal properties of derris. Nevertheless the combination of derris root and lime-sulfur with a spreader gave sufficiently good results against the green apple aphid to warrant tests as a substitute for nicotine-lime-sulfur in the field.

Ginsburg, Schmitt, and Granett (126, 127) in 1934 reported on the toxicity of various extracts of derris root to sucking and chewing insects. Two extracts of derris root, one containing a high percentage of rotenone, the other no rotenone, were equally toxic to aphids in dilutions of 1:20,000 or lower. Based on tests of extracts with different species of insects, including the green apple aphid, the following conclusions were drawn:

> Water-soluble organic solvents such as acetone and alcohol are able to extract practically all of the water-soluble and water-insoluble ingredients of derris root that are toxic to sucking insects. Either continuous distillation, or soaking with subsequent filtration and washing, extracts all the active principles that act as contact poison when acetone or alcohol is used. Water does not extract all the toxic principles of derris root. At low dilutions the water extracts compared well in toxicity with acetone and alcohol extracts, but proved inferior to them in high dilutions. Water extracts rapidly deteriorate on standing, with resultant loss of toxicity. Alcohol extracts slowly lose toxicity upon standing. Acetone extracts do not show any appreciable changes in toxicity upon

standing. The toxicity of derris extract varies with different species of insects. Derris extracts were more toxic to insects than were solutions of pure rotenone, although the concentration of rotenone was practically the same in each case. Rotenone alone is not an adequate criterion to evaluate the toxicity of derris root to insects.

Farrar (98) in 1936 reported that tests made in Illinois showed that extracts of pyrethrum, derris, or cube were not so efficient against A. pomi as was nicotine mixed with oil emulsion. The addition of soap increased the killing power of an oil containing such extracts, but not enough to warrant the added cost of the extracts.

Etablissements Rotenia in 1938 reported insecticide tests against A. pomi on apple and pear trees (see discussion under A. papaveris, on p. 8).

The Wisconsin Agricultural Experiment Station (321) in 1939 reported very good results with an experimental derris dust applied at the rate of about 1 pound per tree. The mixture was made up of 12 pounds of ground derris root (5 percent rotenone), 24 pounds of talc, 12 pounds of dusting sulfur, and 12 pounds of Goulac. Within a week after this mixture was used practically all the aphids had been destroyed. The only aphids found were a few winged adults that apparently had flown in from other trees, and some offspring of such insects. A dust made up of 10 pounds of 40 percent nicotine sulfate to 125 pounds of lime, so as to give about a 3 percent nicotine content, was also tested. When used at the rate of approximately 1/2 pound per tree, this material gave only fair control. Two days after treatment the nicotine-lime mixture seemed to be giving about as good control as derris, but a week after dusting the comparison was very much in favor of derris.

Aphis rumicis L., the bean aphid

McIndoo, Sievers, and Abbott (189) in 1919 reported that derris powder, used as a dust under practical conditions, was effective against bean aphids. McIndoo and Sievers (188) in 1924 reported cube powder to be effective against bean aphids, both as a dust and as an infusion.

Fryer et al. (107) in 1923 used A. rumicis as one of the test insects to determine the insecticidal value of different samples of Derris elliptica roots. Aphids were less susceptible than were certain caterpillars. Broadbeans heavily infested with bean aphids were sprayed with emulsions of the root extract of strengths of 4, 2, 1, and 0.5 percent of the root. The toxic action was extremely slow and uncertain, while nicotine oleate in a dose containing 0.05 percent of nicotine was immediately and almost completely effective.

Gimlette (120) in 1923 reported work that H. E. Durham did with derris in 1903. Derris had no effect as a contact poison on A. rumicis.

Tattersfield and Roach (264) in 1923 referred to Durham's work on derris in which he found the bean aphid resistant to wet application.

The Rothamsted Experimental Station (237) in 1924 reported that

the seeds and leaves of Tephrosia vogelii were about as toxic as nicotine, the test insect presumably being the bean aphid.

Tattersfield (256, 257) in 1925 reported that extracts prepared from black and white haiari (Lonchocarpus spp.) with water and organic solvents (particularly the latter) had been found highly poisonous to aphids [presumably A. rumicis] as contact insecticides. In 1927 he reported that the roots and stems of both black and white haiari were toxic to A. rumicis but that the leaves were not. Tubatoxin (rotenone) from Derris elliptica, at a concentration of 0.25 percent, was almost completely toxic to bean aphids. Six species of Tephrosia were also tested against bean aphids, with the following results:

Species	Parts tested	Result
T. vogelii	Leaves	Toxic
Do.	Seeds	Do.
Do.	Stems	Less toxic than leaves and seeds
Do.	Roots	Do.
T. toxicaria	Do	Toxic
Do.	Stems	Do.
Do.	Leaves	Not toxic
T. macropoda	Roots	Toxic
Do.	Stems	Do.
T. candida	--	Low toxicity
T. hookeriana	--	Do.
T. purpurea	--	Do.

Tattersfield, Gimingham, and Morris (261, 262) in 1925 reported that both alcoholic and aqueous extracts of Tephrosia vogelii Hook. were found to have high toxicity to A. rumicis as contact poisons. The toxic effect of the concentrated extracts on this insect was about the same as that of nicotine. Aqueous extracts of the leaves and seed proved very toxic when a suitable wetting reagent was used with them and were preferable to those made with organic solvents; the latter on drying tended to become somewhat insoluble, and the aqueous extracts had about the same toxicity. The aqueous and alcoholic extracts of a given weight of seed also had an equal toxicity, but the dried extracts prepared by means of organic solvents were more readily worked up into an emulsion. The stems were less poisonous than either leaves or seeds. The same authors in 1926 reported that alcoholic extracts of the roots and stems of white haiari and the stems of black haiari (both species of Lonchocarpus from British Guiana) possess notable insecticidal properties when tested on the bean aphid. Crystals isolated from these plants were identical with tubatoxin (= rotenone) from Derris elliptica. Rotenone at a concentration of 2.5 to 0.075 gm. per liter killed all aphids; 0.01 gm. per liter caused 20 percent to be moribund. Rotenone proved to be several times more toxic than nicotine. The alcoholic extracts of the roots of Tephrosia toxicaria and the leaves of T. vogelii also possess notable insecticidal properties when tested on A. rumicis. The roots and stems of T. candida are less toxic. The most toxic substances isolated from T.

toxicaria and T. vogelii were resinous. Crystals closely corresponding to tephrosin, as isolated by Hanriot, were less toxic.

Tattersfield and Gimingham (259, 260) in 1927 referred to their previous work with white and black haiari and stated that the tubatoxin (rotenone) these plants contain is unquestionably one of the most potent insecticides. The toxicity to the black bean aphid of products isolated from haiari, compared with nicotine, is shown in graphs. In 1932 they reported that samples of roots, stems, and leaves of Derris scandens from British Guiana and branches, roots, and leaves of D. trifoliata (uliginosa) from India and Siam showed little or no toxicity to bean aphids.

In preliminary trials the plant material was ground fine, extracted with alcohol or water, and the extracts diluted with a 0.5 percent solution of nontoxic saponin. A high concentration (equivalent to 1 to 5 percent of the plant material) was tried first. The insect used in most of the experiments was A. rumicis, feeding on broadbean plants, and bred, so far as possible, under standardized conditions. The alcohol or aqueous extracts of Tephrosia candida, T. purpurea, T. heckmanniana, and T. hookeriana showed little or no toxicity. The seeds of T. hookeriana showed some toxicity. The alcoholic extracts of the roots, and to a less extent of the stems, of T. macropoda from Natal possess considerable contact-insecticidal value. The leaves are of little value. The bark of Millettia pachycarpa Benth. was not toxic, but the alcoholic extracts of stems, seeds, and pods of Mundulea suberosa Benth. from India showed definite activity as contact insecticides. One specimen of the seeds and pods of Lonchocarpus latifolius from Trinidad showed slight toxicity.

A. rumicis is not appreciably controlled by sprays of derris which, according to Durham (91) in 1926, is essentially a stomach poison. In an insectary experiment it was killed completely but slowly by derris, 5 pounds to 100 imperial gallons of water, according to Kelsall et al. (169) in 1926.

Necton (derris extract in fish oil), 197.5 gm. plus an equal weight of soap in 40 imperial gallons of water, killed from 50 to 100 percent of bean aphids. --Institute of Physical and Chemical Research (162) in 1927.

Turner (271) in 1932 reported the results of work carried on during 1928 to 1931, inclusive, with cube extract and with rotenone obtained from cube.

Davidson (63, 64) in 1930 reported the following results of tests of aqueous suspensions of pure rotenone upon the bean aphid:

Concentration (gm.:cc.)	Mortality (percent)
1:100,000	99.5
1:200,000	100.0
1:300,000	97.0

A dust composed of 2 parts of rotenone and 98 parts of diatomaceous

earth killed 100 percent of these aphids on nasturtium in a greenhouse. Racemic deguelin killed 100 percent at 1:10,000; tephrosin 100 percent at 1:5,000; and toxicarol 94.5 percent at 1:500.

Shepard, using the bean aphid as the test insect, noted that in acetone or in alcohol rotenone decomposes only very slowly, but in aqueous suspensions made from these solutions it suffers a loss in toxicity on standing. --Davidson and Jones (65) in 1931.

Shepard (241) in 1931 tested the relative toxicity of rotenone and nicotine to the bean aphid. The rotenone was first dissolved in 95 percent alcohol (0.25 gm. in 100 cc.). It was found necessary to warm the mixture somewhat in a water bath to dissolve the rotenone entirely. On dilution with distilled water a stable milky suspension resulted. Colonies of A. rumicis on nasturtium plants were sprayed with the various dilutions. Both rotenone and nicotine were tested in duplicate at the same concentration on the same day, all the tests being made within as few days as possible. The spray mixtures were made fresh each day. Saponin at 1-percent concentration was used as spreader, the required amount of stock solution of 5- to 10-percent saponin being added after the rotenone suspension was diluted somewhat with water. At concentrations of 0.001, 0.01, and 0.02 gm. per 100 cc. rotenone was more toxic than nicotine. Rotenone sprays prepared from acetone and alcohol stock solutions were equally toxic against A. rumicis. A suspension of rotenone (0.01 percent) in 0.01 normal sodium hydroxide when fresh killed 71.2 percent of bean aphids, as compared with 38.7 percent at the end of 8 days. In distilled water the drop in mortality was from 93.4 to 79.9 and in 0.01 normal sulfuric acid from 93.9 to 67.0 percent in the same time. Acid caused a clotting of the rotenone particles. Cube extract in potassium oleate at 1:50,000 killed 94.5 percent of A. rumicis, but after standing 18 days the kill at 1:60,000 dropped from 76.1 to 46.7 percent, indicating deterioration of the cube extract within this time. Cube extract in oil emulsified in water with a sulfonate emulsifier (cube 1:200,000 and oil 0.5 percent) killed 80.3 percent of bean aphids, whereas the oil alone killed 18.5 percent.

Garman (117) in 1934 reported laboratory and greenhouse tests of commercial extracts of derris and of cube against the bean aphid on nasturtiums. Five commercial rotenone preparations and two commercial pyrethrum-rotenone combinations were tested. It was found that the rotenone or pyrethrin content of these preparations must be increased if they are to compare favorably as aphicides with nicotine and anabasine products.

Gimingham (119) in 1934 described recent work on insecticides in Great Britain. Several species of the genus Tephrosia showed marked insecticidal properties against aphids [probably A. rumicis], the leaves and seeds of T. vogelii, the roots of T. toxicaria, and the roots and stems of T. macropoda all yielding highly toxic extracts. Extracts of white and black haiari (Lonchocarpus spp.) from British Guiana proved highly toxic to aphids.

The bean aphid was used as a test insect by Badertscher and Wotherspoon (11) in 1935 in testing the decomposition of derris and pyrethrum powders when exposed to the light from a Uviarc mercury-vapor lamp. An

aqueous suspension (rotenone 1:40,000) made by adding an acetone extract of derris to water killed 67.1 percent of these aphids in 24 hours.

Granett (133) in 1935 used bean aphids in testing the insecticidal values of derris marcs extracted with certain water-soluble and water-insoluble solvents. Ethyl alcohol was the only solvent which removed practically all the insecticidal substances from derris.

Ginsburg and Granett (124) in 1935 reported on the aphicidal properties of derris and cube root: Derris and cube, as finely ground dusts, water suspensions, and extracts, were tested against various species of aphids. Tests against A. rumicis with derris samples ranging from 0 to 9 percent rotenone showed that the toxicity was in the order of the rotenone content, but did not bear a direct relationship to it. It was stated that a derris sample containing 5-percent of rotenone and high total acetone extractives should prove as efficient for practical purposes as roots of higher rotenone content. The rate of kill was slower when derris was applied as a dust than when used as either water suspension or extract. Tests were made against A. rumicis of a sample of derris root and a sample of cube root to compare the aphicidal properties of these materials. The derris root selected contained 5 percent of rotenone and 17.9 percent of acetone extractives while the cube root contained 5 percent of rotenone and 16.7 percent of acetone extractives. The samples were compared as dusts, water suspensions, and acetone extracts. On the whole the differences in toxicity to aphids observed were too small to warrant a definite distinction between the two samples. Apparently derris and cube, provided they have the same rotenone and total-extractive content, are equally toxic to aphids. Roark (234) in 1938, in a review of the comparative value of derris and cube, referred to the work of these investigators.

Lever (181) in 1935 published the results of tests of Derris trifoliata from the British Solomon Islands. Specimens of roots, stems, and leaves were examined by the Rothamsted Experimental Station by spraying alcoholic extracts on A. rumicis. Results were as follows:

Derris species	Sample	Concentration of alcoholic extractives	Mortality
		Percent	Percent
D. trifoliata	Roots from Savo: 4	0.46	40
Do.	Stems from Savo: 3	1.17	60
Do.	Roots from Gizo: 4	0.46	45
Do.	Stems from Savo: 6	1.58	71
Do.	Leaves from Savo: 7	1.37	85
D. elliptica	Roots from Malaya: 7	0.07	62

Martin (192) in 1936 reported finding about 0.4 percent of rotenone in a specimen of Tephrosia macropoda Harv. from the Natal Herbarium, Department of Agriculture, Durban. Qualitative insecticide tests using a cold alcoholic extract of the finely ground root diluted with saponin solution were made on A. rumicis. At concentrations equivalent to 0.25

and 0.1 percent of the root, the percentages of moribund and dead insects recorded on the third day after spraying were 95 and 50 percent, respectively. The root thus shows a decided toxic action to this insect.

Foliafume (a pyrethrum-derris spray with spreader) at 1:400 killed 88 percent in 48 hours. --Penick and Company (223) in 1936.

Van der Vecht (288) in 1937 tested the method of Jones and Smith (165), using the results obtained by Tattersfield and Martin with different species of derris against A. rumicis. This method gives good results in evaluating derris containing more than 4 percent of rotenone; the toxic value of Derris malaccensis (containing from 0 to 2.7 percent rotenone) is best expressed by the formula: Value = rotenone content + 1/3 remainder of extract.

Crawford-Benson (57) in 1938 experimented with field-collected A. rumicis, but results were completely unreliable. These aphids were also reared in a greenhouse under standard conditions and used for laboratory testing of liquid contact insecticides, especially derris preparations. The results of trials on any one day were comparable and indicated the comparative toxicities of the insecticides tested, but when the same insecticide was tested on different days the results were incoordinate.

Gunderson (134) in 1938 recommended derris against bean aphids. Howes (156) in 1938 reported tests made at the Rothamsted Experimental Station on insects [presumably the bean aphid] with alcoholic extracts of the roots of Tephrosia macropoda cultivated in Natal. A concentration of 0.25 percent of a 2-year-old root killed 100 percent of the insects.

Tattersfield and Martin (263) in 1938 reported on the toxicity to the bean aphid of certain products isolated from derris root. The toxicities to A. rumicis of rotenone, toxicarol precursor, sumatrol, toxicarol, and the residual resins from the Sumatra-type and Derris elliptica roots were determined. The toxicity in descending order was rotenone > D. elliptica resin > Sumatra-type resin > sumatrol = toxicarol precursor > inactive toxicarol. Rotenone was 6 times as toxic as the Sumatra-type resin, 4 times as toxic as that derived from D. elliptica, and from 13 to 15 times as toxic as the toxicarol precursor.

Aphis sambuci L., a black aphid

Derris or rotenone suspensions at a concentration of 1:5000 or 1:6250 were effective. --DeBussy et al. (32), in 1935.

Aphis spiraecola Patch, the spirea aphid, or green citrus aphid

McIndoo, Sievers, and Abbott (189) in 1919 reported that an alcoholic extract of derris added to water at the rate of extract from 1 pound of powder to 100 gallons of water, plus 2 pounds of fish-oil soap, killed only 30 percent of this aphid. When derris powder was soaked in soap solution 2 days and the mixture sprayed, 50 percent of the aphids were killed.

McIndoo and Sievers (188) in 1924 reported that a cold alcoholic extract of cube plus soap in water (1 + 2 + 100) killed 95 percent of this species within 24 hours. The dry cube resin dissolved in alcohol and sprayed with soap in water (1 + 2 + 100) killed only 60 percent within 2 days.

Watson (302) in 1925 wrote that "Derris oil" [Derrisol?] 1 tablespoon to a gallon of water was an effective dip for the control of the citrus aphid in Florida. The infested terminal growth was bent over into a bucket containing the solution.

The Florida Agricultural Experiment Station (102, 103, 104) reported in 1926 that Derrisol was tried against the citrus aphid, in comparison with nicotine sulfate. Its action was much slower but it seemed to have a repellent effect for a day or two. It did not penetrate the curled leaves so well as did nicotine sulfate. This station in 1931 reported that an extract of Tephrosia virginiana was ineffective against this species; and in its annual report for 1934 stated that good control of the green citrus aphid was obtained with a product containing 50 percent of white oil and 0.33 percent of rotenone.

Fryer (108) in 1926 gave the following directions for the use of Derrisol: Derrisol should be diluted with water 1:10 and this solution then added to water to make a final dilution of 1 pint of Derrisol per 100 gallons. The Derrisol should never be added directly to the water in the spray tank, as a dilution of uniform strength is difficult to obtain in this manner. Soap may be used with Derrisol, but its use is unnecessary. Derrisol can be used as a mixed spray with oil emulsion, lime-sulfur, bordeaux, and arsenates, care being taken that the Derrisol is added only to the diluted insecticides. It is most important not to add the Derrisol to the concentrated spray material when mixed spraying is desired, because some of the active ingredient may be thrown out of solution and the final efficiency of the spray mixture be thereby impaired. Derrisol was effective against the citrus aphid, and also against aphids and other insect pests on hops and fruits in England.

Lenfest (180) in 1926 mentioned Derrisol and Black Leaf 40 as about the two best contact insecticides for use against citrus aphids in Florida. Derrisol spreads well without soap. Lime-sulfur mixed with Derrisol will kill rust mites and red spiders, as well as aphids.

Miller (202) in 1929 reported tests to control the green citrus aphid in Florida. Derris extract at any of the ordinary spraying strengths was not toxic to plants. When used against aphids at 1 part to 800 it gave a 99-percent kill and at 1 part to 1,000 a 95-percent kill. This insecticide, however, is a slow-acting material and will not kill all the aphids in 24 hours, but shows its real effectiveness in 36 to 48 hours. Miller was not able to find that derris extracts had any more lasting effect or repellent action than nicotine sulfate.

Tissot and Thompson (269) in 1930 recorded the results of laboratory tests with nicotine, pyrethrum, and derris preparations made at Gainesville, Fla. Against the green citrus aphid, Neoton, 1-1/4 pounds to 100 gallons of water, plus Grandpa's Wonder Spray, 5 pounds to 100 gallons,

gave a mortality of 92.4 percent. Most aphids that survived were inside curled leaves. Neoton at the same concentration, plus Octagon laundry soap, 2-1/2 pounds to 100 gallons, gave a mortality of 81.9 percent, and plus 5 pounds Octagon laundry soap, a mortality of 94.4 percent. Neoton at 2-1/2 pounds per 100 gallons, plus Octagon laundry soap, 5 pounds per 100 gallons, gave a mortality of 96.2 percent. The highest kill (98.8 percent) in this series of tests was obtained with 50 percent of free nicotine at 1:1,000 plus 0.5-percent Penetrol. Reference to these results was made by Thompson (267) before the Florida State Horticultural Society at its 1930 meeting. Derrisol also was stated to give good control.

Darley (62) in 1931 reported laboratory tests using this species. Rotenone at 1:100,000 as a contact spray compared favorably with nicotine at 1:10,000 and pyrethrins at 1:74,800 with Penetrol (1:200) in each spray.

Hamilton and Gemmell (137) in 1934 compared the effectiveness of derris, pyrethrum, and hellebore powders against different insects. Dusts containing derris root powder (air-floated, 4 percent rotenone), pyrethrum powder (1.16 percent pyrethrins), mixtures of derris root powder, pyrethrum powder, and hellebore powder (0.8 percent active principle) were tested. Inert clay was used as a diluent. Laboratory tests with A. spiraecola showed that diluted derris powder (rotenone, 1 percent), pyrethrum powder, or mixtures of the two were effective, but hellebore was not effective. Derris powder appeared to be more effective when mixed with water and applied as a spray, whereas the pyrethrum was more effective when applied as a dust. [Mixtures of derris and pyrethrum powders were slightly more effective when applied as dusts than when applied as sprays.]

Farrar (98) in 1936 reported that extracts of pyrethrum, derris, or cube were not so efficient against A. spiraecola as nicotine mixed with oil emulsion. The addition of soap increased the killing power of an oil containing such extracts, but not enough to warrant the added cost of the extracts.

Aphis tavaresi DelG., an orange aphid

Easily controlled by Derrisol 1:800 or by Katakilla 5 pounds per 100 imperial gallons of water. --Andries (10) in 1932.

Worsley (324) in 1936 reported that bark of Mundulea suberosa Benth. (0.9 percent rotenone) from Moa district, Tanganyika Territory, East Africa, was almost equal to derris root (5.4 percent rotenone) in toxicity to this aphid. Concentrations necessary to give 100-percent kill of A. tavaresi were 0.25 percent for nicotine, 0.29 percent for derris root, and 0.33 percent for Mundulea bark.

Bhatta and Narayanan (15) in 1937 stated that in small-scale field trials extracts of seeds of Tephrosia candida and of the stem bark of Mundulea sericea were effective at 0.25- and 0.5-percent concentrations, respectively, against A. tavaresi on citrus.

Van der Vecht (288) in 1937 tested the method of Jones and Smith (180) using the results obtained by Worsley with different species of derris against A. tavaresi. This method gives good results [illegible]

derris containing more than 4 percent of rotenone; the toxic value of Derris malaccensis (from 0 to 2.7 percent rotenone) is best expressed by the following formula: Value = rotenone content + 1/3 remainder of extract.

Brevicoryne brassicae (L.), the cabbage aphid

Neeton 197.5 gm., plus an equal weight of soap in 40 imperial gallons of water, killed 100 percent. --Institute Physical and Chemical Research (162) in 1927.

Davidson (63, 64) in 1930 reported the following results:

Concentration of spray	Percentage of aphids killed by spraying with			
	Rotenone	Racemic deguelin	Tephrosin	Toxicarol
1:500	--	--	--	0
1:5,000	--	94.0	0	--
1:10,000	--	--	--	--
1:20,000	--	--	--	--
1:30,000	--	--	--	--
1:100,000	100	--	--	--
1:200,000	97.4	--	--	--

The cabbage aphid was used as a test insect by Davidson and Jones (65) in 1931 in studying the loss of toxicity suffered by rotenone in certain solvents and in aqueous suspension. Rotenone at 1:10,000 killed 98.5 percent of this species.

Shepard (241) in 1931 referred to unpublished work by Davidson, who found that individual tests on the cabbage aphid with rotenone suspensions at 1:100,000, but treated in different ways, resulted in 89.0, 48.4, 64.0, 22.4, and 46.5-percent mortality at the end of 1 day, but at the end of 4 days the same experiments, respectively, gave 95.6, 88.1, 95.5, 70.0, and 90.7-percent mortality. These data show the desirability of following the course of poisoning until the action is complete.

Hamilton and Gemmell (37) in 1934 reported that pyrethrum dust and a mixture of derris and pyrethrum were effective in laboratory tests against the cabbage aphid, while derris (1-percent rotenone) was less so.

Ginsburg and Granett (124) in 1935 reported that several hundred young cabbage plants infested with the cabbage aphid were sprayed thoroughly on both surfaces of the leaf with a commercial acetone extract of derris at a concentration of 0.5 pint per 100 gallons of water plus 0.25 percent of soap. Approximately 90- to 100- percent kill was noted 2 days later. Houghton and Byrne in 1935 stated in a letter to the chief of the Bureau of Entomology and Plant Quarantine that they failed to control the cabbage aphid with a dust containing 2.92-percent of ether extractives but no rotenone. Howard et al. (154) in 1935 reported derris to be less effective than nicotine for control of the cabbage aphid. Huckett and

Hervey (157, 277) in 1935 reported that cabbage aphids were not satisfactorily controlled by derris or cube dust mixtures.

The New York State Agricultural Experiment Station (212, 213) in 1935 reported that derris dust (0.5-percent rotenone) had little value in protecting Danish cabbage against the cabbage aphid. In 1936 this station reported that aphids in the cauliflower seedbed were effectively controlled with dusts containing 0.5 and 0.33 percent of rotenone, the applications being made late in the evening under calm conditions, in anticipation of a period of high relative humidity during the night.

Veitch (290) in 1935 reported that derris sprays are highly effective for the control of the cabbage aphid.

Walker and Anderson (296) in 1935 reported the following results when cabbage plants were dipped in concentrations of derris preparations strong enough to control cabbage aphids:

Material	Concentration	Percentage survival of plants	
		Tops dipped	Tops and roots dipped
Pysol - - - - - - - - - -	1:100	96	74
Red Arrow - - - - - - - -	1:100	96	95
Super Agricultural Spray	1:100	93	81

Derris dust failed to give satisfactory control. --Walker and Anderson (297) in 1935; also reported by Cory (277) in 1935.

In laboratory tests a dust containing 50 parts of derris (3.95 percent rotenone) and 50 parts of gypsum caused 20-percent mortality in 2 days. In field experiments dusts containing 25 percent of derris proved unsatisfactory. --Kelsall and Stultz (170) in 1937.

Dibble, of Michigan State College, in advertising literature in 1938, recommended derris or pyrethrum dust or spray for the control of cabbage aphids. Early control keeps the population low and prevents much difficulty later. Sprays do not stick well on cabbage, and dusts are often given first choice. In large patches spraying is cheaper if good equipment is available.

Gunderson (134) of Iowa State College Extension Service in 1938 recommended derris or cube dust for the control of cabbage aphids. Petherbridge and Wright (226) in 1938 reported derris dusts to be inferior to a 3 percent nicotine dust for the control of the cabbage aphid. Howard and Nelson (155) in 1939 reported that a nicotine-hydrated-lime dust mixture (2.4 percent nicotine) was much more toxic to this insect in southern Ohio than were dust mixtures containing 1 percent of rotenone derived from cube and containing either sodium oleyl sulfate or peanut oil as conditioners and either talc or a mixture of equal parts of tobacco dust and sulfur as diluents. None of the dust mixtures containing cube gave satisfactory control of this aphid.

Derris or cube dusts have given unsatisfactory results in tests for the control of the cabbage aphid. --Walker and Anderson (298) in August 1939.

Howard (152) in 1940 reported that a nicotine-dust mixture was superior for cabbage aphid control to the rotenone-tobacco-sulfur mixture recommended for turnip aphid control in the South (cf. report on Rhopalosiphum pseudobrassicae, p. 47).

The Wisconsin Agricultural Experiment Station (321) in 1940 reported that a mixture of derris 25 pounds, hydrated lime 37.5 pounds, dusting sulfur 37.5 pounds, and nicotine (Black Leaf 40) 5 pounds gave good control of both cabbage worms and cabbage aphids. The sulfur kept the derris effective against cabbage worms, even though the reaction of the mixture was sufficiently alkaline to release the nicotine necessary for aphid control.

Capitophorus fragariae (Theo.), the strawberry aphid of England

Rogers, King, and Massee (236) in 1939 reported that, for the control of C. fragariae in England, derris sprays and dusts, nicotine dust, and pyrethrum spray have been tried extensively but do not give sufficient control to warrant their use commercially.

Capitophorus ribis (L.), the currant aphid

The currant aphid was not controlled by a dust of equal parts of derris and hydrated lime, according to Kelsall et al. (169) in 1926. Although derris and soap is highly toxic to aphids and similar soft-bodied sucking insects, a dry powder appears to be less efficacious. Thus a derris dust failed to control a bad attack of C. ribis on red currants in a garden in June 1935, but when a wet spray was used satisfactory results were obtained.

Capitophorus rosarum (Kalt.)

The powdered roots of four species of derris applied as dusts killed from 63 to 92 percent of these aphids on roses in 4 days. --DeOng (75) in 1930.

Foliafume (a pyrethrum-derris spray with spreader) at 1:400 killed 91 percent in 48 hours. --Penick and Company (223) in 1936.

Cavariella sp.

Brittain (21) in 1925 reported that field tests to control Cavariella sp. on parsnips were made with derris (2-1/2 pounds of derris and 4 pounds of soap powder per 100 imperial gallons of water) and a commercial preparation of derris, Polvo (2-1/2 pounds per 100 imperial gallons). Each reduced the infestation very little, even when soap was added. In the insectary infested leaves were dipped directly into different insecticides. Derris, 3 pounds per 100 imperial gallons, killed only 10.4 percent; derris, 2-1/2 pounds per 100 imperial gallons plus 4 pounds McDougall's soap powder, killed 91 percent.

Cinara sabinae (Gillette & Palmer), a red cedar aphid

McDaniel (187) in 1934 reported that this red aphid can be controlled by derris sprays used according to the directions of the maker.

Eriosoma lanigerum (Hausm.), the woolly apple aphid

The derris preparations Contraphin and Katakilla were useless against this insect. --Wahl and Muller (294) in 1915. Gimlette (120) in 1923 reported work that H. E. Durham did with derris in 1903. Derris had no effect as a contact poison on the woolly apple aphid. Tattersfield and Roach (264) in 1923 also referred to unpublished results of work by Durham, who found the woolly aphid resistant to the wet application of derris. Durham (91) in 1926 gave an interesting account of his early work with derris, which started in the Malay States in 1902 and continued in England in 1904. An extensive series of trials on the woolly aphid were carried on throughout the summer, both with spraying and with careful use of a camel's-hair brush so as to get thorough wetting of the patches, which had a milky appearance when treated. The woolly aphid is difficult to wet, but in no case was there any appreciable diminution. Durham expressed the opinion that, whether or not there may be a contact effect, the main utility of the drug must be as a stomach poison.

Neoton 375 gm. plus 1,125 gm. of soap in 40 imperial gallons of water killed 100 percent. --Institute of Physical and Chemical Research (162) in 1927.

DeOng (75) in 1930 used this as a test insect in determining the insecticidal value of four species of derris (powdered stems applied as dust). The results after 30 days' exposure were as follows:

Derris species	Mortality Percent
D. elliptica	100
D. trifoliata	100
D. heptaphylla	55
D. polyantha	84
Check (no treatment)	48

The Handelsmuseum of the Koloniaal Instituut of Amsterdam (8) in 1930 reported that derris was an exceptional material for control of aphids on flowers and fruits in the greenhouse, but that the woolly aphid was protected by its covering.

Overley and Overholser (218) in 1932 reported that apple trees in Washington that had been sprayed with rotenone were free from woolly aphids, whereas on other plots there was a general infestation. Rotenone in oil (1:25,000) was highly effective in laboratory tests. --Turner (271) in 1932. Derris or rotenone suspensions at a concentration of 1:5,000 or 1:6,250 were effective. --DeBussy et al. (32) in 1935.

Rotenone and dihydrorotenone were about equally toxic to this species on apples, when used as a spray containing 0.1 to 0.5 percent of Agral. At 1:5,000 rotenone killed from 80 to 90 percent and at the

same concentration dihydrorotenone killed from 65 to 75 percent. --Van der Laan (177) in 1935.

Etablissements Rotenia in 1938, in a letter to R. C. Roark, stated that this species is repelled by a proprietary product containing 12 percent of cube of 6 percent rotenone content.

Hyalopterus arundinis (F.) (H. pruni (F.)), the mealy plum aphid

Garman (116) in 1928 reported experiments made in Connecticut with insecticides offered as substitutes for nicotine sulfate. One of the commercial preparations of derris was tried in 1927 against the mealy plum aphid and showed good killing power. It was evident that soap or casein lime was needed in combination. The product investigated did not mix well with lime-sulfur solution of winter strength. Tests with commercial preparations of derris and pyrethrum against the mealy plum aphid gave the following results:

Material	Dilution	Mortality
		Percent
Derris preparation	1 lb. to 100 gal.	88.3
Do	2 lb. to 100 gal.	97.6
Pyrethrum soap	5 lb. to 100 gal.	94.4
Nicotine sulfate	1 lb. to 100 gal.	92.2
Check, no treatment	--	0

Derris or rotenone suspensions at a concentration of 1:5,000 or 1:6,250 were effective. --DeBussy et al. (30) in 1935.

Hysteroneura setariae (Thos.), the rusty plum aphid

Farrar (98) in 1936 reported that extracts of pyrethrum, derris, or cube were not so efficient against H. setariae as was nicotine mixed with oil emulsion. The addition of soap increased the killing power of an oil containing such extracts, but not enough to warrant the added cost of the extracts.

Macrosiphoniella sanborni (Gill.), the chrysanthemum aphid

Derris dust was effective. --McIndoo and Sievers (188) in 1924.

Ginsburg and Granett (124) in 1935 reported results with a commercial acetone extract of derris. This extract contained 5 percent of rotenone and 16 percent of total extractives. About 2,000 chrysanthemum plants infested with M. sanborni were sprayed with the commercial acetone extract of derris at dilutions of 1/3 pint to 100 gallons of water and 0.2 percent of coconut-oil soap. Observations 2 days later showed practically 100-percent kill of this insect.

Macrosiphum liriodendri (Mon.), the tuliptree aphid

McIndoo, Sievers, and Abbott (189) in 1919 reported that the alco-

holic extracts of various species of derris plus soap were effective against this aphid. Derris applied as a dust killed 92.3 percent. In 1924 McIndoo and Sievers (188) reported the cold alcoholic extract of cube used with soap to be effective. A dust of 2 parts of rotenone and 98 parts of diatomaceous earth killed 88.4 percent of these aphids on a tuliptree. --Davidson (63) in 1930.

Macrosiphum pisi (Kalt.), the pea aphid

Cory (53, 54) reported in 1923 that lime to which 5 percent of Derrisine was added, used at the rate of 50 pounds per acre, killed only 10 percent of (Illinoia) Macrosiphum pisi. In 1938 he reported that rotenone dust was especially efficient in the control of the pea aphid.

Rockwood and Chamberlin (235) in May 1934 reported on the action of derris dust on the pea aphid at Forest Grove, Oreg. Austrian field peas infested by aphids were dusted on April 16 with derris dust containing a silica filler, the rotenone content being 0.5 and 0.7 percent. The maximum reduction of aphids in the best parts of these plots was not over 50 percent and nothing approaching practical control was obtained.

Dudley (84), of the Madison, Wis., laboratory of the Bureau, in December 1935 reported insecticide tests against the pea aphid. After the pea vines became heavily infested, the application of derris sprays containing 0.0148 percent of rotenone reduced the aphid population approximately 95 percent, in comparison with the untreated plots, and resulted in a profitable yield of peas. Most of the derris sprays were applied with commercially prepared sulfonated phenyl phenol (1:600), which functioned as a spreader and wetting agent. In comparative tests with this agent, sodium lauryl sulfate (1:1,500), and sodium oleyl sulfate (1:600) no significant difference could be determined in the performance of the three materials. Derris sprays without spreaders or wetting agents caused slower but eventually as good reductions in aphid populations as when spreaders and wetting agents were used. Derris dust containing 0.5 percent of rotenone applied in a heavy infestation gave erratic results, inferior to those from the derris sprays.

Bronson (22, 23, 24, 25, 26, 27) in 1936 reported the results of greenhouse tests of derris against the pea aphid made at Madison, Wis. Tests in which aphid-infested plants were treated with various dust mixtures and placed in a chamber where the relative humidity remained at approximately 100 percent for a period of 16 hours after treatment gave much more effective control than in comparable tests in which the dusted plants were left in an open greenhouse. Derris-dust mixtures containing 0.4 percent of rotenone, with talc as the diluent, plus sodium oleyl sulfate as a conditioner, were more effective in greenhouse experiments than were derris-dust mixtures with kaolin or gypsum as the diluent, plus sodium oleyl sulfate as the conditioner, when the plants were left in the open. When treated plants were placed in a moist chamber, where the prevailing relative humidity was approximately 100 percent, no significant differences could be detected between the performance of each of the three dust mixtures with different diluents. Better results were obtained with derris-dust mixtures containing a conditioner (i.e., sodium oleyl sulfate special) than with the unconditioned dusts. During the winter of

1935 potted pea plants were sprayed with derris and later infested with aphids. The spray consisted of ground derris root (3.2 percent rotenone and 13 percent total extractives) used at a dilution to obtain 0.0115 percent of rotenone (3 pounds per 100 gallons of water) and one of two spreaders and wetting agents, either a sulfated butylated diphenol [Aresket 240] at a dilution of 1:600 of a 40-percent aqueous solution, or a sodium oleyl sulfate, special, at the dilution of 1:1,000. Small, uninfested potted pea plants were sprayed thoroughly, allowed to dry for 24 hours, then lightly infested with third and fourth pea aphid instars, and properly caged, there being an average of four plants to the pot. Bronson concluded that derris spray, containing either of the two spreaders and wetting agents used in these experiments, protects potted pea plants artificially infested with the pea aphid for a period of 7 days against any building up of the original infestation.

In 1936 Bronson described a ball mill for mixing cube or derris powder with a diluent and with an activator or conditioner. These dusts have proved to be toxic against the pea aphid and it is believed that thorough mixing greatly increased their effectiveness. In 1937 he described an improved apparatus for mixing derris or cube powder with a diluent and a conditioner. One hundred pounds of dust containing 1 percent of rotenone for use against the pea aphid is made by mixing 25 pounds of derris or cube root powder (4 percent rotenone), 72 pounds of talc or other suitable diluent, 1 pound of conditioner (wetter and spreading agent), and 2 pounds of water. Satisfactory conditioners are sodium oleyl sulfate and an alkylphenylbenzenesulfonic acid. Tests were made in a greenhouse at Madison, Wis., with different spreading, wetting, and sticking agents used with derris sprays against the pea aphid. A commercially prepared product containing a sodium oleyl alcohol sulfate was the most effective agent used with derris, and resins or other adhesive agents were not effective in protecting the active ingredients of derris from loss either through decomposition or from being washed with a water spray. The pea plants were first sprayed with a derris solution containing one of the spreading, wetting, or sticking agents. Some of these treated plants were hand-infested 24 hours after they had been sprayed; others were washed twice with water and infested 5 days after being sprayed. The results showed some residual effect of derris in all the tests in which plants were infested with the pea aphid 24 hours after being sprayed, but probably no residual effect of derris was apparent in the plants washed twice after being sprayed, and then infested with the pea aphid.

In July 1938 Bronson issued revised directions for mixing rotenone dusts (see 26) in a cement mixer. The derris or cube root powder should be of such a degree of fineness that not less than 90 percent of it will pass through a 200-mesh sieve and all the material (100 percent) should pass through an 80-mesh sieve. The talc or other diluent used should be of such a degree of fineness that all the material will pass through a 300-mesh sieve. In most of the experiments and field tests against the pea aphid thus far, a sodium oleyl sulfate (Avirol, IN-438) was used and proved satisfactory. Other proprietary conditioners also proved satisfactory.

Dudley, Bronson, and Carroll (87, 88, 89) in 1936 reported the

results of tests made in 1935 at Madison with derris (rotenone 3.7 percent, total carbon tetrachloride extractives 16.1 percent) against the pea aphid. Three series of experiments were conducted: (1) In a greenhouse late in the winter and early in the spring, (2) in the field during the normal pea-growing season, and (3) in the field late in the season on late-planted peas. The greenhouse tests demonstrated that ground derris as a spray applied at the rate of from 1-1/2 to 5 pounds per 100 gallons of water (0.006 to 0.022 percent rotenone), with a spreader and wetting agent, killed nearly 100 percent of the aphids on the treated plants. The aphids died throughout a period of from 3 to 5 days, and practically no reproduction occurred in the interim.

Many summer field tests on both small and large plots demonstrated that ground derris as a spray, applied at the rate of from 1/4 pound to 5 pounds per 100 gallons (0.0009 to 0.022 percent rotenone), with a spreader and wetting agent, killed more than 90 percent of the aphids on the treated plants; that from 3 to 5 days were required to obtain the maximum mortality; and that little or no reproduction occurred during that period. In these tests the application of derris sprays increased the yield of shelled peas approximately 88 percent over that of untreated checks.

A large number of tests on late-planted peas revealed that derris as a spray, with a spreader and wetting agent, applied prior to aphid infestation protected the plants from appreciable damage for several weeks and resulted in an ultimate infestation considerably lower than that in the untreated checks; that heavy applications of derris sprays after the incidence of an infestation protected peas from damage from a commercial standpoint for nearly a month, enabling them to produce a normal crop of pods; that heavy applications of derris sprays with any one of several spreaders and wetting agents, made after the infestation had become heavy, killed approximately 95 percent of the aphids; that derris sprays controlled the aphid more quickly and to a higher degree than did derris dusts (rotenone 0.4 percent); and that concentrations of derris as low as 1/4 to 1/2 pound (0.0009 to 0.0019 percent rotenone) per 100 gallons, with spreaders and wetting agents, killed approximately as large a percentage of aphids as did 3 pounds per 100 gallons. Wetting and spreading agents tested included a pine-oil product, diphenyl butyl sodium sulfonate, sodium lauryl sulfate, and sodium oleyl sulfate.

In 1937 the same authors summarized the results of field experiments with derris and cube against the pea aphid. Dusts tried included derris powder plus talc, cube powder plus talc, and derris powder plus talc and sodium oleyl sulfate, all diluted to a content of 1 percent rotenone. In order to be effective a spray of cube or derris should contain at least 0.005 percent of rotenone. The dusts were applied at the average rate of 46 pounds per acre; the sprays, at the average rate of 144 gallons per acre. Increases in yield from five dusting tests ranged from 59 to 240 percent and averaged 138 percent. Increases in yield from three spraying tests ranged from 96 to 109 percent and averaged 101 percent. A limited number of tests indicated no difference between the effect of derris and of cube sprays. In the sprays various wetting agents were tried, including butyl diphenyl sodium sulfonate. In comparable dusting tests the special derris-talc dust was appreciably better than

the regular dust in reducing the infestation on entire plants, but both dusts were equally effective in reducing the infestation in blossom clusters. This special derris-talc dust was made by atomizing into the derris-talc, while it was being mixed, a solution composed of 1 percent of a sodium oleyl alcohol sulfate and 2 percent of water. Considering both spraying and dusting tests together, the special derris-talc dust appeared slightly better than the sprays in reducing the infestation on entire plants. Dusts and sprays reduced the infestation in blossom clusters equally well. These results were referred to by Roark (234) in his review of the comparative value of derris and cube.

Bronson and Dudley (28) in 1938 reported on conditioning agents for increasing the effectiveness of rotenone-bearing dusts against the pea aphid. They concluded that, in both the greenhouse and the field, derris- or cube-dust mixtures conditioned with a spreading and wetting agent have been shown to be superior, as insecticides against the pea aphid, to plain derris- or cube-dust mixtures. Under field conditions this superiority of the conditioned dust mixtures has amounted to approximately 12 percent, which may be the difference between satisfactory and unsatisfactory aphid control. In general, conditioned derris- or cube-dust mixtures reinforced by the addition of nicotine or an aliphatic thiocyanate have been superior to conditioned dust mixtures. Field data indicated that derris and cube were equally effective against the pea aphid.

Dudley and Bronson (85) reported results of experiments against the pea aphid in southern Wisconsin in 1938, wherein dust mixtures and sprays containing rotenone, as well as nicotine vapor, applied to large-scale experimental plots, indicated that all these insecticides resulted in an increase in yield, as compared with the untreated check plots, and that, owing to the conditions of pea aphid infestation existing that year, there were no outstanding differences between these treatments. From the 1938 work against the pea aphid they concluded that, even with excellent growing conditions and a light aphid infestation, an adequate financial return was obtained by treating the peas with the above-named insecticides.

Dudley and Bronson also reported (222) that in a large replicated-plot experiment satisfactory aphid control was obtained by treatment with derris spray, derris-dust mixture, and nicotine vapor, but not with nicotine dust. The largest increase in the yield of shelled peas resulted from the derris-dust treatments, with the nicotine-vapor treatment second, and the derris-spray treatment third. The plots treated with nicotine dust yielded less than the checks. Derris spray was used at a rotenone concentration of 0.01 percent plus sodium oleyl sulfate and in some cases also 1 percent aliphatic thiocyanate.

In February 1939 Dudley and Bronson (86) reported that an analysis of the wind velocities at the experimental plots at Waunakee, Wis., during the 24-hour period of each day during June for the 3 years 1936-38 showed that on an average during this period, when dusting operations against the pea aphid are usually performed in Wisconsin, there was a total of 68 hours of daylight when the wind velocities ranged from 0 to 4 miles per hour, as compared with a total of 223 nocturnal hours when the wind was in the same velocity range. It is within this velocity range that dusting operations against the pea aphid can be most effectively performed

under Wisconsin conditions. The analysis demonstrated further that the wind velocities remained within a range of from 0 to 4 miles per hour for consecutive periods of 3 hours or more at a time approximately two and one-half times as often during the night as during daylight hours. These data indicate the desirability of applying dust mixtures for pea aphid control during the night, whenever conditions will permit.

Bronson and Stone (29) in 1938 reported that, in an extensive series of greenhouse tests with several combinations of derris-dust mixtures against the pea aphid, a derris-dust mixture containing 0.4 percent of rotenone, with talc as the diluent and conditioned with sodium oleyl sulfate as a wetter and spreader (1 percent), plus a crude peanut-oil emulsion (2 percent), gave a satisfactory mortality of the pea aphid through all the ranges of relative humidity from 20 to 85 percent. The application of derris-dust mixtures that did not contain any conditioning materials resulted in a low mortality of the pea aphid at all the ranges of relative humidity encountered. The application of derris-dust mixtures containing sodium oleyl sulfate (1 percent) as a wetter and spreader, but without crude peanut-oil emulsion, gave a low mortality of the pea aphid at low relative humidity and a satisfactory mortality of the test insects after the expiration of 4 days in instances when the relative humidity was 50 percent or higher. It was concluded, on the basis of these tests in the greenhouse, that derris-dust mixtures containing the sodium oleyl sulfate as a wetter and spreader were decidedly more toxic to the pea aphid than a dust mixture not containing this ingredient; whereas the dust mixture containing this same wetter and spreader, plus a crude peanut-oil emulsion, was greatly superior to the dust mixture that did not contain this vegetable oil. These results corroborate previously reported findings of Howard and Fulton, of the Columbus, Ohio, laboratory, that the addition of peanut-oil emulsions to sprays or dust mixtures greatly increased their efficiency against large plant bugs. If the results of these greenhouse tests are borne out under field conditions the effectiveness of dust mixtures containing rotenone for use against the pea aphid may be increased greatly by the addition of peanut-oil emulsion; but thus far results in the field have varied with humidity.

The Secretary of Agriculture (274) in his 1936 annual report wrote as follows:

> Laboratory and field tests with organic insecticides, particularly derris and cube, have brought many modifications in the recommendations for the control of certain insect pests. It has been demonstrated that these insecticides, which do not leave residues objectionable from the standpoint of human health, can be effectively used against a number of different truck-crop pests. * * * The further usefulness of these recently developed materials is evidenced by the determination that one application of sprays or dusts of derris or cube is effective against the pea aphid over a longer period than other recommended material, such as pyrethrum and nicotine.

This statement also appears in the Yearbook of the Department of Agriculture (299) for 1937.

White (305) in April 1936 issued suggestions on the use of derris sprays for control of the pea aphid. For this purpose derris should contain 4 percent of rotenone and be used at the rate of 2 pounds per 100 gallons. At least 150 gallons of the spray should be applied per acre under a pressure of not less than 250 pounds, when the plants are dry. A wetting agent should be used at the rate of about 1/2 pound dry weight per 100 gallons of water. Sodium lauryl sulfate and sodium oleyl sulfate are suggested as suitable wetting agents, and a sulfated phenylphenol at 1:1,500 (dry basis) has been used successfully.

The New York Agricultural Experiment Station (213, 214) in 1936 reported that derris was being tested for the control of the pea aphid. In 1937 this station stated that rotenone sprays, properly applied with adequate equipment, proved highly effective in killing the pea aphid, but that rotenone dusts had not been tested in the field sufficiently to bring out all their possible limitations.

The United States Department of Agriculture, Bureau of Entomology and Plant Quarantine (278) in its annual report for 1935 stated that the pea aphid caused heavy losses to the pea growers in Wisconsin, New York, and Ohio. The investigations consisted primarily of field-plot tests with several insecticides and, while the results to date are only preliminary and cannot be used as a basis for recommendations on pea aphid control, the indications are that a derris-powder spray may be useful against the pea aphid.

The Bureau of Entomology and Plant Quarantine (280) in its annual report for 1936 stated that encouraging results in the control of the pea aphid were obtained in 1935 with sprays containing derris, and special field experiments were conducted with derris sprays and derris dusts in California, Florida, and Virginia late in the winter and in the spring of 1936. The results of these field tests indicated that derris sprays were effective in controlling the pea aphid and that, under favorable conditions, insecticides containing rotenone, the active ingredient of derris and cube, had a residual effect that protected the treated plants from severe damage for an extended period. It was determined that, in general, sprays or dusts containing nicotine have a more rapid action against the pea aphid than insecticides containing rotenone, but the latter have a much longer residual effect. This residual effect of rotenone-containing insecticides, as observed in field tests, was substantiated by laboratory studies. Continued field work late in the spring of 1936 demonstrated that a derris dust containing a specially prepared spreading agent yielded results comparable to those from a derris spray, the dust being prepared by atomizing a sodium oleyl sulfate into the derris-dust mixture while it was being revolved in a steel-drum ball mixer. The Bureau (281) in its 1937 annual report stated that cube or derris dusts plus sodium oleyl sulfate are effective against pea aphids and leave no rotenone or other constituents in peas taken from treated plants. In its 1938 annual report the Bureau (283) gave the results of much work with rotenone products. During the springs of 1937 and 1938 the pea aphid was particularly troublesome in Maryland, Delaware, and New Jersey. Investigations were continued in Wisconsin on the control of this pest. In these control tests emphasis was placed on the time of treatment for maximum benefit in protection of the crop. Field and laboratory tests were continued with derris and cube

dusts and sprays and the results showed that these materials, applied either as spray or dust, appeared to be the most satisfactory ones developed thus far for the control of this aphid. Adequate spraying or dusting equipment is essential to aphid control, as is proper material and time of treatment. In 1939 the Bureau (285) reported that insecticides containing rotenone had proved effective.

In 1938 the Bureau (282) published suggestions for the control of the pea aphid, prepared by a committee of entomologists at the annual meeting of the American Association of Economic Entomologists at Indianapolis, Ind., on December 27, 1937. The following recommendations were based on observations and data accumulated from experimental work done east of the Rocky Mountains:

> Satisfactory control of the pea aphid has been accomplished by several methods. These include, without suggestion of preference (1) dusting, (2) use of nicotine vaporizer, and (3) spraying. Success in the use of any of these methods will depend entirely upon adequate and efficient equipment and properly timed, thorough application. (1) Dusting with derris or cube: Field experiments with derris or cube dust mixtures containing talc or other suitable carriers, conditioned with a liquid spreading and wetting agent, have resulted in satisfactory control. Such dust should contain approximately 1 percent of rotenone. In applying these dusts the boom should be completely enclosed and a trailer 25 feet or more in length should be used. Dusts should be applied at the rate of 35 to 40 pounds per acre. The speed of the machine should not exceed 3 miles per hour or 300 feet per minute. Dusting is much less effective when the wind velocity exceeds 8 to 10 miles per hour. Spraying is an effective method of control, but its economic usefulness is conditioned by the nearness of an adequate water supply. On the basis of ground derris or cube root containing 4 percent of rotenone, 3 pounds should be used per 100 gallons of water, with corresponding dilutions where the content is greater or less than 4 percent of rotenone. A spreading and wetting agent, in either liquid or dry form, is necessary. The application per acre should be from 125 to 200 gallons. Pressure should be from 225 to 300 pounds, and depends on size of disc apertures, type of nozzle, and pump capacity. An infestation of 35 aphids per sweep of a standard collecting net, for an average of 5 sweeps in different parts of the field, usually indicates that treatment should be begun.

The Bureau in February 1938 distributed a summary of the remarks made at the Pea Aphid Conference (222) at Indianapolis, Ind., in December 1937. Shropshire of Illinois reported on the efficiency of the numerous wetting agents offered for use with derris and cube. Over 50 of these combinations and dilutions were tested in replicated plots, and it was found that some of the best wetting agents were the poorest for use with derris or cube for aphid control on peas. Results of experimental work in 1937 tended to verify results obtained in 1936 with both nicotine and derris or cube for pea aphid control. They further show that cube is as

effective as derris, assuming that the rotenone and total extractives are approximately the same in both samples. Derris or cube with a rotenone content of 4 percent was effective for pea aphid control when used at the rate of 2 or 3 pounds per 100 gallons of spray, assuming that the spray was applied at the rate of 125 to 150 gallons per acre. Aresket (liquid) used at the rate of 1 to 600 was used as a standard for comparison with other spreaders.

An extensive set of dust trials was planned for 1937 following limited work in 1936. Most of the dusts were made up to contain 1 percent of rotenone, other ingredients being varied as desired. Variables included diluents, wetting agents, some suggested by Dudley and Bronson, and irritants such as nicotine and certain thiocyanates. Results with rotenone-bearing dusts varied in 1937, as in 1936. In many instances the results were excellent, but in certain experiments they were unsatisfactory. Apparently the poor performance was due to some weather condition, such as absence of free moisture (dew or rain) on the plants. Notwithstanding some very poor results obtained with rotenone-bearing dusts, it is believed that they have sufficient merit to warrant recommendation with reservation. The use of wetting agents or irritants in dusts for use on peas was not recommended.

A committee of entomologists representing a number of the State experiment stations and the Bureau of Entomology and Plant Quarantine, of the United States Department of Agriculture (279), at the December 1936 meeting of the American Association of Economic Entomologists at Atlantic City, issued the following suggestions for control of the pea aphid:

> Dusting with derris or cube: Preliminary experiments with these materials, with a carrier such as talc, conditioned with a spreader and wetting agent, have given satisfactory control. Their use is suggested only on an experimental basis. Such dust should contain approximately 1 percent of rotenone.
>
> Spraying with derris or cube: On the basis of ground derris or cube root containing 4 percent of rotenone, 3 pounds should be used per 100 gallons of water. Corresponding dilutions should be used with derris or cube containing more or less than 4 percent of rotenone. A spreader and wetting agent is necessary. The application per acre should be from 150 to 200 gallons. Pressure should not be less than 300 pounds.

Cory and Graham (55) in 1936 reported that derris without a spreader gave poor control of the pea aphid, but with sodium lauryl sulfate good control was obtained. Ten pounds of rotenone material (0.009 percent rotenone in the finished spray) plus 1/2 pound of sodium lauryl sulfate were used to 100 gallons of spray. Rotenone remained effective against the aphids longer than did nicotine and soap. One year's experience in Maryland with rotenone (without spreader) showed a slight decrease in aphid infestation and no increase in yield of peas, over the unsprayed plots. The next year's experience with rotenone (with spreader) showed

a decrease in aphid infestation in plots that had an initial infestation and an increase in yield of peas ranging from 128.3 to 404.0 percent over the unsprayed plots. The highest yields, however, had no initial infestation.

Graham (130) in 1937 reported that in 1932 Pyrote (a pyrethrum-rotenone product), 1 gallon to 400 gallons of spray, gave an 89.78 percent kill of pea aphids in Maryland. In 1935 in the same field where the nicotine and soap tests were conducted, plots of the same size were laid out and a 3 percent rotenone-derris dust, without a spreader, at the rate of 4 pounds per 100 gallons of spray, was applied at the same time as the above-mentioned nicotine spray. Records were made on yield and aphid infestation. The results showed a slight decrease in aphid infestation and no increase in yield of peas over the check plot.

In 1936 derris plus sodium lauryl sulfate was tested. Plot 5 received one application of derris dust containing 0.75 percent of rotenone at the rate of 10 pounds plus 1/2 pound of sodium lauryl sulfate spreader to 100 gallons of spray at the beginning of the blooming period. This plot produced 742 pounds of shelled peas per acre, an increase of 128.3 percent over the check. The aphid infestation before the peas were sprayed was 15 per tip but 24 hours after the peas were sprayed it was only 2 per tip.

Plot 7 received one application of derris dust containing rotenone at the rate of 6 pounds (active derris extractive material, including rotenone, 8 percent) plus 1/2 pound of sodium lauryl sulfate spreader per 100 gallons of spray. This application was applied 10 days before the peas began to bloom, and produced 1,128 pounds of shelled peas per acre, an increase of 247 percent over the check plot. No aphids were present when the spray was applied but 12 days later the infestation averaged 0.5 aphid per tip.

Plot 8 received two applications of a similar derris dust, the first 10 days before blooming started, the second when the peas began to bloom. The yield in shelled peas per acre was 1,638 pounds, or an increase of 404 percent over the check. No aphids were present before the first application nor 2 days after the second.

Plot 9 received one application of derris containing rotenone, the same strength and spreader as in Plots 7 and 8. Application was made when the peas first came into bloom. The yield in shelled peas per acre was 817 pounds, or 151.3 percent increase over the check. The aphid infestation just before the spray was applied was 14 per tip, but 24 hours after the application it was 7 per tip.

At harvest time the rotenone-treated plots were green and succulent and the pods well formed and tender; whereas check plots and nicotine-sulfate-treated plots were practically dead and the pods poorly developed. Another index to the efficiency of derris dust containing rotenone over nicotine sulfate was the number of aphids on the ground after harvest. Under the derris-rotenone-sprayed plots only an occasional aphid could be found on the plot that received two applications, and a few more on the plots that received one application, whereas under the nicotine-

sulfate-sprayed plots and check plots the ground was literally alive with aphids. The rotenone remained effective against the aphids over a much longer period than did nicotine sulfate and soap.

Graham and Ditman, of Maryland, (222) reported that in 1937 derris and cube sprays, when properly applied, gave good results. Nicotine fumigation gave the most complete and quickest kill. Derris dusts, possibly because of improper application, seemed less effective than sprays. Derris powder (8-percent total extractives) was used at the rate of 2 or 4 pounds per 100 gallons, plus sodium Lauryl sulfate (1/4 or 1/2 pound) or Orthex Spreader (1 pint) as a wetting agent.

Ditman (81) in December 1939 reported on the practical aspects of pea aphid control. Dusting with cube or derris (1 percent rotenone) was probably the most commonly used treatment for the control of the pea aphid by Maryland growers. Only a very small acreage was treated with the nicotine vaporizer and no nicotine dust was applied. The evidence from the observations on experimental and commercial treatments indicate that cube sprays were not so efficient as derris sprays for pea aphid control and that the additional cost of derris over cube will probably pay good dividends. Observations on commercial control indicate that derris is better than cube and that a derris dust of 1 percent-rotenone content should be used by those who prefer dusting to spraying. All dusting should be done at night when the air is still and when vines are heavy with dew.

Ditman, Cory, and Graham (82) in August 1939 reported tests on the control of the pea aphid in Maryland in 1938. The following were tested as sprays: Derris + Aresket (rotenone 2.6 percent); cube; cube plus Vatsol OS (rotenone 3.8 percent); Agicide (1937 pack, stated to contain 1-percent rotenone). The derris and cube were used at the rate of 4 pounds per 100 gallons. Agicide and derris gave a greater reduction of aphids per sweep and per tip than did cube. Agicide gave a slightly higher kill of aphids than either derris or cube and derris gave a better kill than cube, by all three of the methods of population estimation. Further examination of the results shows that the treatments held the aphid population in check for a period of approximately 10 days, though the percentage of infested tips increased slightly in plots treated with Agicide and cube, derris remaining about the same. This increase in the number of tips infested after spraying tends to discount the idea of any residual effect of the spray.

In the severe and extended infestation of the pea aphid of 1938, one application of insecticide was not sufficient to obtain good control. There was little difference in yield of plots receiving a single early application of cube and those receiving a single late application, as neither treatment gave satisfactory control. The number of aphids per sweep, aphids per tip, and the percentage of tips infested were satisfactory indices to the degree of control obtained by various spray treatments. Sometimes, however, counts of all aphids on entire plants showed that the above estimates of populations indicated a greater percentage reduction than actually occurred.

Graham (131) in 1939 recommended the following for control of the pea aphid in Maryland:

> Spray.-- Three pounds of micronized cube or derris (4-percent rotenone), plus spreader, to 100 gallons of water at 150 gallons per acre and 500 pounds pressure.
>
> Dust.-- Finely ground derris or cube (0.75- to 1.0-percent rotenone) at 35 to 40 pounds per acre. The machine should not exceed 3 miles and the wind velocity 8 or 9 miles per hour.

Rotenone-bearing materials used as sprays give satisfactory control of the pea aphid when timely and properly applied. Rotenone-bearing dusts are equal to rotenone sprays in reducing aphid infestation under extremely hot and dry conditions. The first application should be made when the aphid infestation is 10 per sweep of the net, with another application 10 days later if the infestation increases.

Graham and Cory (132) in August 1939 reported that recent experiments, consisting of large field plots, on the control of the pea aphid in Maryland indicate that rotenone-bearing materials have great possibilities in pea aphid control. In 1936 plots sprayed with derris containing 2.9 percent of rotenone gave a maximum increase of 404 percent yield over unsprayed plots. Further tests with rotenone-bearing materials in 1937 and 1938 confirm, in general, the results obtained in 1936. In 1937 and 1938 tests were made with --

> Derris (rotenone 2.9 percent) 2 or 4 pounds per 100 gallons + sodium lauryl sulfate 1/4 or 1/2 pound per 100 gallons
> Ditto, 4 pounds per 100 gallons + Orthex spreader (1:800)
> Ditto, 1 pound per 100 gallons + nicotine sulfate 1:3200 + soap 1:1600
> Derris (rotenone 3.8 percent) 3 pounds per 100 gallons
> Agicide 1:200
> Bonide (rotenone 2 percent) 1:300
> Cube (rotenone 4.4 percent) 3 pounds per 100 gallons + sodium lauryl sulfate 1/4 pound per 100 gallons
> Fixed (stabilized) derris 3 pounds per 100 gallons
> Dust containing 0.75 percent rotenone.

The authors concluded that 3 years of experience with derris as an insecticide for pea aphid control in large field plots indicated that when the application is timely and thorough the results are satisfactory. One year's experience with cube in comparison with derris indicated that, even though the rotenone content of cube is higher than that of derris, the latter gives better control. Several years of experience on the timing of sprays for pea aphid control show that the best results are obtained when the aphid infestation is not greater than 1 per tip or 10 per sweep when the first application is made. If the first spray is

applied 6 or 8 days before blooming, a later application is likely to be necessary. One year of experiments with rotenone (cube) dusting showed it to be inferior to rotenone sprays. In general, dusting was less effective than spraying.

Howard and Mason (153) in 1937 summarized information on the use of derris and cube sprays and dusts. It may be necessary to use a dust containing 1 percent of rotenone in the control of the pea aphid. A spray containing 3 pounds of derris or cube powder (4 percent rotenone) is effective. A wetting agent is necessary.

Knowlton and Sorenson (173) in April 1937 recommended derris or cube (4 percent rotenone) at 3 pounds per 100 gallons of water applied at a pressure of at least 300 pounds for the control of the pea aphid in Utah. To be most effective such a spray should be applied on a quiet, warm day and before the pea aphid causes noticeable injury to the plants.

The Maine Agricultural Experiment Station (190) in 1937 discussed the use of rotenone against pea aphids in that State. Reference was made to the use of highly concentrated rotenone or of nicotine in a liquid base, the base often being a light, highly refined oil, and to their distribution from airplanes. Preliminary experiments with hand apparatus strongly indicated that an effective wetter and spreader is necessary for satisfactory control. The percentage of rotenone, the fineness of materials, the presence of an effective adhesive wetter or spreader, thoroughness of application, proper timing of application of the insecticide in relation to the presence of aphids on the peas, and weather conditions all may influence the effectiveness of the dust or spray. Observations in Maine during the last 3 years have led to the conclusion that the stage of growth of the pea vines is an important consideration in timing the sprays. If aphids are present when the peas are in bloom they are a potential threat to the crop. Rotenone applied then will remain effective for about a week, and under Maine conditions a second application is rarely necessary.

The Oregon Agricultural Experiment Station (217) in 1937 reported that preliminary observations indicate the rotenone-bearing sprays to be of value in combating the pea aphid. The nicotine sulfate soap is also of value but its effects do not appear to last as long as those of the rotenone-bearing sprays. Various new spreading and wetting agents were also used.

Walker (205) in 1937 reported that 1/2 pound of Ultrawet added to 3 pounds of cube (4 percent rotenone and 14 percent total extractives) in 100 gallons of water increased the control of the pea aphid from 93.5 to 98.7 percent, and 1 pound of Ultrawet plus 3 pounds of cube gave a control of 98.8 percent.

Craufurd-Benson (57) in 1938 reported that pea aphids were reared in a greenhouse under standard conditions and used for the laboratory testing of liquid contact insecticides, especially derris preparations. The results of trials on any one day were comparable and indicated the comparative toxicities of the insecticides tested, but when the same insecticide was tested on different days the results were incoordinate.

When pea aphids were collected in the field the results were completely unreliable.

Dunlap and Turner (90) in 1938 recommended cube of 4 percent rotenone content, 4 pounds per 100 gallons, with a spreader such as Ultrawet (1/2 pound) or Areskap (6 ounces) for combating the pea aphid. Gunderson (134) in 1938 recommended derris against pea aphids.

Knowlton, Smith, and Harmston (172) in 1938 reported on the control of the pea aphid in northern Utah in 1937. "Vapo Fumer" mixture (nicotine) fumigation gave about 99-percent control.

Sprays.-- Agicide semifluid spray concentrate was used as a spray at dilutions of 1:50, 1:100, 1:150, and 1:200 with good pea aphid kills, even under hand-sprayer conditions. An analysis of the data indicated that there was no significant difference between the four concentrations supplied. Spray tests with derris and cube used at the rate of 3 pounds of a 4-percent rotenone-bearing dust to 100 gallons of water, to which Lethane spreader was added, gave equally good results, there being no significant difference between these and the Agicide sprays. Use of higher concentrations did not appear to be justified by the results obtained.

Dusts.-- Applications of 1-, 2-, and 3-percent rotenone-bearing Derricide produced rather heavy kills of the pea aphid, comparable in effect to the spray applications listed above. Agicide 1-percent rotenone dust usually gave good results. Applications of a 0.5-percent rotenone dust did not give significant control.

Knowlton, of Utah (222), reported that in 1937 ground cube and derris root gave good control as a spray when diluted at the rate of 3 pounds of 4-percent rotenone-bearing dust (or equivalent) to each 100 gallons of water, to which a liquid spreading and wetting agent was added. "Agicide" semifluid spray concentrate also was effective, no significant difference in control being noted between applications at strengths of 1:50, 1:100, 1:150, and 1:200. Cube- and derris-dust mixtures containing from 1 to 2 percent of rotenone usually gave good control, but the results were less consistent than with the derris- and cube-spray treatments.

Parks and Pierstorff (219) in 1938 recommended rotenone spray for the control of the pea aphid on peas. They stated that a little Kayso or powdered skim milk should be added as a spreader.

Stearns (251) in 1938 recommended nicotine sulfate dust or a spray of derris or cube for the control of the pea aphid in Delaware. The dust should be applied under a trailer 100 feet long, made of air-tight material, and a wetting and spreading agent should be used in the sprays. In trials of 12 spray and dust combinations, sprays reduced infestation more than dusts. Combinations including derris were more satisfactory than those including nicotine, the best being 3 pounds of derris (4 percent rotenone), with 1 pint of sulfated fatty alcohol containing a synthetic adhesive per 100 gallons of spray, which reduced the population by about 85 percent, as compared with that on an untreated plot.

Hutson, of Michigan (222), in 1937 reported the order of effectiveness of insecticides for the control of the pea aphid to be as follows: Nicotine vaporizer, nicotine dust, sprays, and rotenone dusts.

Pepper, of New Jersey (222), reported tests in 1937 with derris powder diluted with talc to a rotenone content of 1 percent. When the wind velocity and the temperature were favorable at the time of application, the 4 percent nicotine dust proved to be more effective than did the derris-root-dust mixtures. The derris-root dust without a conditioning agent proved to be more effective than the derris-root dust containing a conditioning agent (1 percent). This was also true in a series of small-plot experiments. No significant differences could be noted in the kill of aphids between applications on dry and on wet foliage, and no residual effects of derris-root dust to the pea aphid was noted. The aphid population, however, was depleted very rapidly by natural enemies. Preliminary experiments were also conducted with vaporized oil sprays applied from an airplane. The oil, of course, contained an insecticide. The insecticides tested in the vaporized oil were nicotine, derris extract, pyrethrum extract, and mixtures of derris and pyrethrum extracts. The data from the experimental plots showed a kill of approximately 75 percent with some of the oil-insecticide combinations. Derris-root dust applied from an airplane proved totally unsatisfactory as a control for the pea aphid.

Hugh Glasgow, of New York (222), reported that in the case of the rotenone-bearing dusts the initial kill in 1937 was often surprisingly good, but the fact that this kill was not always so consistent or so uniformly high as where either rotenone sprays or nicotine preparations were used was somewhat disturbing.

Houde (144) in 1939 recommended cube or derris dust (1 percent rotenone) plus 0.5 to 1 percent wetter, at 35 to 40 pounds per acre, preferably at high temperature and humidity; also a spray, 3 pounds of powder of 4 percent rotenone content per 100 gallons, plus a wetter, at 125 to 200 gallons per acre at 250 to 600 pounds' pressure; also a derris extract in oil applied as a vapor spray from airplanes.

Jones (166) in the 4-H Club Insect Manual issued February 1939 recommended derris or cube for the control of the pea aphid.

Nettles (205), of South Carolina, in 1939 wrote that recent experiments in the North and West show that derris is a promising material for the control of the garden pea aphid but has not been tested as yet in the South.

Crosby, Chupp, and Leiby (58) in February 1939 wrote that a dust containing 1 percent of rotenone may be substituted for the nicotine-lime dust with good results for the control of the pea aphid. It should be applied at the rate of 30 to 50 pounds to the acre. Rotenone may also be used as a spray. Use 3 to 4 pounds of material containing 4 to 5 percent of rotenone per 100 gallons of water plus 8 to 10 ounces of one of the sulfated alcohols, or similar spreader.

Walker and Anderson (290) in August 1939 reported that vaporized

nicotine applied while the plants were dry gave the most satisfactory control of the pea aphid under field conditions by the pea growers in the Norfolk, Va., area. Derris and cube sprays in combination with suitable wetting and spreading agents have given good control of the pea aphid in experimental tests but failed to give satisfactory results in some field trials by pea growers. Santex R, containing a derris extract, has given promising results as a spray, in comparison with sprays containing cube powder. In general, derris and cube have not given so good control of the pea aphid when used as dusts as when used as sprays. Tests were made with cube powder 4 pounds or 8 pounds per 100 gallons plus SS-3, 1:600; cube-talc dust (rotenone 1 percent); cube-walnut-shell flour (rotenone 1 percent); also the same plus 1 percent of Vatsol OS or 1 percent of Grasselli IN-181 P.

Stantex-R (now called Stantex R 50) is a mixture of 80 percent of Stantex Dispersing Oil and 20 percent of a derris extract containing 5 gm. of rotenone in 100 cc. of a camphor-sassafras-base oil. Stantex Dispersing Oil is a mineral oil containing a small percentage of oleic acid and a wetting agent. Both are made by Standard Chemical Products, Inc., Hoboken, N. J. SS-3 (now called Grasselli Spreader-Sticker) contains sodium oleyl sulfate as the spreader and a synthetic plastic as the sticker. Grasselli IN-181 P contains sodium lauryl sulfate in a powdered form. Other wetting agents tested with cube were Areskap, Dry Aresket, Elgete (emulsified peanut oil), Grasselli IN-438 (sodium oleyl sulfate), Santomerse, Stantex Spreader Soap, and Ultrawet. A dust containing 0.75 percent of rotenone and 0.098 percent of pyrethrins gave best results when applied late in the evening, and vaporized nicotine gave best results when the plants were free from dew.

Wilson and Dieter (311), of Wisconsin, reported in 1939 that the results obtained against the pea aphid with rotenone-bearing materials, although variable because of widely different climatic conditions in 1937 and 1938, were reasonably satisfactory in both years. Such materials were effective when sufficient moisture was present and the temperature sufficiently high (approximately 70° F.). Observations indicate that in general it is possible to obtain commercial control of pea aphids on pea vines with one properly timed treatment. In 1938 field tests were run with all the commercial dusts sold in Wisconsin and, when the temperatures were high, satisfactory results were obtained from each dust after 24 hours. Self-mixed dusts were also used. Derris (5 percent rotenone and 14 percent total ether extractives), and cube were mixed with various diluents so that the final mixture contained 1 percent of rotenone, 1 percent of liquid wetting and spreading agent, and 2 percent of water by weight. These dusts were applied at 30 pounds per acre and all were effective in reducing the pea aphid population more than 90 percent on treated plots after 24 hours.

Rotenone dusts are most effective when applied to peas wet with dew or rain and when the weather is fairly warm (above 70° F.). Heavy rain following as early as 5 or 6 hours after the dust is applied does not seriously injure the effectiveness of the treatment, provided the peas are moist when dusted. Under favorable conditions 20 pounds per acre of a dust containing 1 percent of rotenone gives good results, but it is safer to use 25 to 30 pounds per acre. --Wisconsin Agricultural Experiment Station (320) in 1939.

Ground derris or cube root has proved effective in killing aphids, and has the advantage of being cheaper to use than nicotine vapor. Rotenone insecticides may be applied in either dust or spray form with almost equally good results, but dusts are generally preferred because they make it unnecessary to haul large quantities of water. The best practice is to treat the peas when the first flower buds appear. Tests made in 1937 and 1938 indicate that rotenone-bearing products are most effective if applied when the humidity is high -- that is, when there is a dew or shortly after a rain. The best time of the day is in the morning, late afternoon, or evening, rather than midday. The fact that night applications are especially effective is presumed to be largely because there is generally some dew on the plants at that time, but absence of wind at night may also prevent the dusts from being blown away.

Another experimental finding is that rotenone dusts are more effective in killing aphids when the temperature is above 70° F. In 1938 early applications made in cool weather did not reduce the number of aphids until after 9 days; but as soon as temperatures became higher, good control resulted within 24 hours. One puzzling fact, which has not been explained, is that rotenone seems to give the peas some protection when applied during cool weather, even though the aphids are not immediately killed. For this reason it is not possible, without further research, to say definitely whether it is wise to wait until the temperature is above 70° before using rotenone dusts.

The Wisconsin Agricultural Experiment Station (316) in 1936 reported excellent control of the pea aphid with sprays of powdered derris root. Dusts were not consistently effective. Yields of peas, as recorded at the factory, showed increases ranging from 68 to 131 percent with the various treatments, as compared with untreated plots. The average increase was 86 percent. In these trials there was a higher percentage of small-sized peas in the check plots than in the treated plots. Trials were made on the late-planted peas with concentrations of 3 pounds per 100 gallons in the fall of 1935. Excellent control of aphids was again obtained, approximately 95 percent of the insects being killed by a heavy application of derris spray. One application after the aphid infestation had begun served to protect the peas from damage for nearly a month. Other trials with concentrations of derris as low as 1/4 to 1/2 pound per 100 gallons of water, with spreaders and wetting agents, killed approximately as large a percentage of aphids as did 3 pounds per 100 gallons. About 200 gallons of spray was required per acre. Derris containing 5.7 percent of rotenone killed slowly over a period of 3, 4, or 5 days, depending on weather conditions. There was little or no reproduction during the period in which aphids were dying. Indications were that when derris sprays were used the plants remained uninfested for a longer period after treatment than with any of the other poisons tested.

The same station (318, 319) in its annual report for 1937 stated that derris-talc dust containing 1 percent of rotenone and sprays containing from 0.005 to 0.015 percent of rotenone gave good control of the pea aphid. Single treatments applied before June 15 resulted in large increases in yield. Of the treatments applied before June 20, five dusting tests produced an average increase in yield of 138 percent, whereas three spraying tests resulted in an average increase of 101 percent. Diphenyl

sodium sulfonate and sodium oleyl sulfate were used as wetting agents. For the control of the pea aphid, canners now have a choice of two effective insecticides--nicotine in a gas form and rotenone in either wet sprays or dusts. Nicotine as now used gives excellent commercial control under proper conditions, and rotenone materials also are good if carefully applied. Any insecticide containing at least 1 percent of rotenone will probably be effective, applied either as a spray or a dust, and all the 1 percent rotenone materials tested, as well as the nicotine-gas method, reduced pea aphid population by 90 to 95 percent within a day or two in trials conducted by Wilson at Columbus in 1937. Field treatments in this and other areas in many instances gave equally good control where the insecticides were properly applied.

The conditions under which rotenone dusts are used may have some bearing on the amount needed. About 30 pounds per acre of a dust containing 1 percent of rotenone is a safe amount under most circumstances. As little as 20 pounds was used with good results in trials in 1938, but it may be risky to try economizing to this extent, particularly if weather conditions are not such as to make the rotenone immediately effective.--Wisconsin Agricultural Experiment Station (320) in May 1939.

The Wisconsin Agricultural Experiment Station (322) in 1940 reported that 2-year trials have indicated that if a properly mixed dust containing 0.75 to 1 percent of rotenone is stored in a dry warehouse, it will usually be about as effective the second year as it is the first. In fact, one good commercial dust held over from the 1937 season gave excellent results in 1938 and also satisfactory results in 1939. Three others mixed in 1938 proved satisfactory in 1939. Experiments in pea aphid control carried out on 57 1/4-acre plots on a farm near Waunakee, Dane county, in 1939 brought out especially favorable results with derris-dust mixtures. Although aphid infestations were very light at this location, derris-dust mixtures appeared to increase yields in several of these tests. Average yield increases in three experiments were 612, 555, and 555 pounds per acre, respectively.

Rotenone dusts cause relatively slight injury to ladybeetles, important aphid predators. Only adult beetles were rather consistently injured by rotenone dust, and even the adults often were able to lay large numbers of eggs after being dusted. Larvae were seldom injured unless they had just molted at the time the dust was applied. The eggs of lady beetles were uninjured, even when heavily coated with dust.

Macrosiphum solanifolii (Ashm.), the potato aphid

McIndoo and Sievers (188) in 1924 reported that cube as a dust and as an infusion was effective, but used as a cold-water extract with soap it had practically no effect. The cold alcoholic extracts of cube and derris plus soap were effective.

Kelsall et al. (169) in 1926 reported the results of tests with derris against the potato aphid in the insectary. The presence of moisture had a marked effect in increasing the toxicity of derris.

A dust containing 2.5 parts of derris and 97.5 parts of hydrated lime gave 100-percent control in 5 days when the foliage was first dipped in water and the dust then blown on. Derris in spray form required 5 pounds per 100 imperial gallons of water to produce 100-percent mortality, while nicotine sulfate (40 percent), 1/2 pint to 100 gallons, gave the same control. In all tests derris was much slower in action than nicotine.

McDaniel (186) in 1928 wrote that the potato aphid was controlled by Derrisol.

Derris dust failed to give satisfactory control in the field.--Walker and Anderson (298); also reported by Cory (277) in 1935.

Manschke (191) in 1937 reported that 96.5 percent of red and green potato aphids on tomato were killed by a spray consisting of 2 pounds of derris powder (4 percent rotenone) per 100 gallons of water plus about 3/4 ounce of coconut-oil soap (40 percent dry soap) per gallon.

The rotenone preparations Cybor, Niagron, and Kubatex and derris were effective.--Massachusetts Agricultural Experiment Station (194) in 1937.

Pepper (224) in 1937 reported on the control of pink and green aphids, M. solanifolii, on tomatoes in New Jersey. Nicotine was more effective than derris or pyrethrum. The estimated results of pyrethrum, derris, and mixtures of pyrethrum-derris dust, as compared with 4 percent nicotine dust, are tabulated as follows:

Treatment	Estimated control (Percent)
Pyrethrum-talc (25:75)	60
Derris dust (0.75 percent rotenone)	35
Pyrethrum 50 pounds, derris root (4 percent rotenone) 20 pounds, and talc 30 pounds	70
A commercial mixture of derris and pyrethrum (0.5 percent rotenone and 0.2 percent pyrethrins)	60
Four percent-nicotine dust	95

Approximately 30 to 35 pounds of the above mixtures was applied per acre. Oils impregnated with pyrethrum and derris extract were sprayed from an airplane. Poor kill (about 25 percent) was obtained from the application of regular kerosene 10 gallons, concentrate of pyrethrum plus derris 1 gallon, and highly refined petroleum distillate 10 gallons plus concentrate of pyrethrum-derris 1 gallon. There was little difference between the treated plots; and, since the percentage kill of aphids was so low and time was limited, actual counts were not made. The airplane sprayer did not break up the spray as fine as was expected. Poor distribution of the fog or oil particles was, no doubt, a part of the cause of poor results.

After adjusting the airplane spraying equipment so as to produce a fine fog, 1 gallon of pyrethrum-derris concentrate to 30 gallons of oil reduced the aphid population 40.1 percent. A later count indicated a reduction of 71.4 percent. Nicotine (1 gallon of 50 percent free nicotine to 27 gallons of oil) reduced the population in the two counts 68.3 and 94.3 percent respectively.

Smith (244) in 1937 reported that derris powder (4 percent rotenone) at 2 pounds per 100 gallons of water plus 1-1/4 pounds (dry basis) coconut-oil soap or 1/2 pound Dry Aresket 300 caused a reduction of 96.5 percent in the population of pink and green potato aphids on tomato plants. Counts were made at the end of 24 hours.

Craufurd-Benson (57) in 1938 experimented with M. solanifolii collected in the field as a test insect for determining the value of liquid contact insecticides, especially derris preparations, but found the results to be completely unreliable.

Gunderson (134) in 1938 recommended derris against potato aphids.

Cube or derris dust is ineffective.--Haude (144) in 1939.

Macrosiphum rosae (L.), the rose aphid

McIndoo and Sievers (188) in 1924 reported that a cold alcoholic, and also a benzene extract of cube were effective when used with soap.

Neoton (derris extract in fish oil) 75 gm. plus twice its weight of soap in 40 imperial gallons killed 100 percent.--Institute of Physical and Chemical Research (162) in 1927.

Foliafume (a pyrethrum-derris spray with spreader) at 1:400 killed 94 percent in 48 hours.--Penick and Company (223) in 1936.

A bed of about 40 rose plants infested with M. rosae was divided into two parts and sprayed with 0.25 and 0.5 pint of commercial acetone derris extract containing 5 percent of rotenone per 100 gallons, respectively, 0.2 percent of soap being used in each case. Complete control of this insect was obtained with the 0.5-pint concentration and about 80 to 90 percent with the 0.25-pint spray mixture.--Ginsburg and Granett (124) in 1935.

Siphonophora Macrosiphum rosae (L.) is killed by a proprietary dust containing 12 percent of cube of 6 percent rotenone content.--Etablissements Rotenia in a letter to P. C. Roark in 1938.

Macrosiphum rudbeckiae (Fitch), the goldenglow aphid; or cone flower aphid

Darley (62) in 1931 reported comparative tests with rotenone, nicotine, and pyrethrum on aphids. Rotenone was used in two stock solutions, one consisting of 0.2 gm. of rotenone, 5 cc. of benzol, and 95 cc. of Penetrol; the other of 1 gm. of rotenone in 50 cc. of acetone. A few preliminary tests against M. rudbeckiae on goldenrod gave the following results: Black Leaf 40 at 1:1,000 (nicotine 1:2,500) produced a

mortality of 56 percent; Nicotrol at 1:200 (nicotine 1:10,000), 97.9 percent; Penethrum at 1:200 (pyrethrins 1:74,800), 80 percent; No. 519 at 1:200 (rotenone 1:100,000), 96.9 percent. The check mortality was 23.2 percent.

Turner (271) in 1932 reported that cube extract dissolved in mineral oil and emulsified with sodium oleate deteriorated during the 5 days following preparation. Applications made at a dilution of 1:250,000 of cube extract against M. rudbeckiae killed from 42.7 to 91.6 percent. Cube extract in mineral oil emulsified with powdered skimmed milk did not decompose on 2 weeks' standing, a dilution of cube extract of 1:300,000 killing from 54.8 to 74.1 percent of the aphids.

Macrosiphum solidaginis (F.)

Turner (271) in 1932 reported that cube extract in oil, emulsified with a sulfonate emulsifier, at a dilution of 1:40,000 killed 81.7 percent of M. solidaginis, whereas a solution of nicotine sulfate (40-percent nicotine) at 1:800 killed only 41.2 percent.

Macrosiphum spp.

McIndoo and Sievers (188) in 1924 reported numerous tests of cube and derris in the form of dusts and alcoholic and aqueous extracts against unidentified aphids designated as Macrosiphum spp. "A" and "C." The alcoholic extracts were the most toxic. The smoke from burning derris and cube powders was effective against the species "C."

Myzus cerasi (F.), the black cherry aphid

The Michigan Agricultural Experiment Station (199) in 1925 reported that derris sprays had given encouraging but not conclusive results against the black cherry aphid.

The Wisconsin Agricultural Experiment Station (313) in 1926 reported that the petal spray is probably the best for cherry aphid control, and Derrisol, imported from England, seemed to possess superior qualities; and in its annual report for 1927 (314) stated that both Derrisol and nicotine sulfate were effective at dilutions of 1:800 parts of water. They were about equally efficient, but Derrisol was cheaper, more pleasant to apply, and gave better coverage, although it took from 24 to 48 hours after spraying for aphids to die.

The same station (315) in 1929 reported that Derrisol applied early in the season before the cherry leaves unfold gave commercial control of the cherry aphid; in 1938 (318) reported that the black cherry aphids in Door County were controlled by various insecticides, including seven products containing rotenone; and in 1940 (322) reported that the evidence of the past season was that derris and bordeaux could be used together for control of the black cherry aphid. Good control resulted when Dri-Spray, a proprietary derris powder, was used at 3-1/4 pounds to 100 gallons of half-strength bordeaux (made up of 1-1/2 pounds of copper sulfate and 2 pounds of lime in 50 gallons of water). Dri-Spray also

gave good results when used alone at 3-1/4 pounds to 100 gallons of water in this experiment, but a commercial cherry grower failed to get entirely satisfactory control of aphids when he applied this same treatment during a cool spell, with temperatures around 60° to 65° F. This indicates that derris sprays to control cherry aphids should be used during warm weather to get good results, as is the case when such insecticides are used for control of pea aphids.

Myzus persicae (Sulz.), the green peach aphid, spinach aphid, or tobacco aphid

McIndoo, Sievers, and Abbott (189) in 1919 reported that the alcoholic extract of derris plus soap (1 pound of powder to 100 gallons of water plus 2 pounds of fish-oil soap) killed 92.5 percent of these aphids. Derris powder used as a dust under practical conditions was also effective. In 1924 McIndoo and Sievers (188) reported that derris used as a fumigant (burned) was effective.

DeOng and White (76) in 1924 reported that a commercial derris extract diluted 1:500 gave a 50-percent control of the green peach aphid. Diluted 1:300 a maximum control of 68 percent was obtained.

Van der Meer Mohr (196) in 1927 reported that M. persicae is a serious pest of tobacco in Deli, Sumatra. The seedbeds are infested from the adjacent forests, and the young plants in the field are either infested in the same way or by the introduction of infested seedlings from the beds. If the beds are very badly infested the seedlings should be destroyed or dipped in derris solution, experiments having shown that this does not harm them. In the plantations a daily watch should be kept for the first traces of infestation. Spraying with a solution of derris is advised. The application must be repeated after 4 to 5 days.

The Deli Proefstation of Medan, Sumatra (69) in 1929 published information on the use of tuba (derris) root extract against M. persicae on tobacco. Fulmek in 1922 was the first to introduce tuba root on a large scale for combating this insect. Even when used in excessive quantities it did not damage the tobacco leaves. Tuba root extract is made as follows: The dried root is chopped into pieces 1 to 2 inches long and mixed with six times its weight of water; when in a fresher condition less water is added. The root is crushed in 20 to 30 minutes by vertically running millstones, then thoroughly sieved, and the residue pressed by a hydraulic press. The expressed liquid passes through a fine sieve and is mixed with the first extract. The liquid is then disinfected with 0.5 percent of formalin and, when put in tightly sealed casks, may keep for some months. This method is satisfactory for the Deli conditions because the extract is made only during the planting season and used within a short time. This is by far the cheapest insecticide for the Deli planters. The manufacture is under continuous control of the entomologists of the experiment station. An average of 60,000 liters of the stock solution is sent yearly to the tobacco planters. Derris is far superior to nicotine sulfate in killing M. persicae. Addition of soap does not affect the aphicidal qualities.

The proefstation (70) in 1931 reported that M. persicae was unusually abundant on tobacco, and large amounts of derris extract were used to combat it. Neoton at 0.1 percent was more effective and cheaper than the 1:45 akar toeba (derris) of the proefstation; however, it was necessary to use a small proportion of soap to prevent the separation of oil from the Neoton, which otherwise leads to unequal distribution of the spray. In 1933 the same station (71) reported comparative experiments made at two places with Neoton and akar toeba, to see whether these insecticides had any influence on the quality of tobacco to which they were applied. The Neoton was used at 0.1 percent, together with some soap; the akar toeba, at a dilution of 1:40 in a 0.1 percent soap solution. Neither treatment had any marked effect on quality. From the insecticidal standpoint, the akar toeba extract was not inferior and there is no reason for replacing it with Neoton. Derrothan as a dust was effective in laboratory tests but Derrothan emulsion burned the tobacco plants. During the 4 months January-April, inclusive, 1932 the akar toeba factory at Sikambing, Sumatra, distributed 708,000 liters of aqueous extract of derris

Davidson (63) in 1930 killed 98.2 percent of these aphids in a greenhouse with rotenone suspended in water at a concentration of 1:100,000 and 94.3 percent at a concentration of 1:200,000. A dust containing 2 parts of rotenone and 98 parts of diatomaceous earth killed 76.6 percent.

This aphid was used as a test insect by Davidson and Jones (65) in 1931 in studying the loss of toxicity suffered by rotenone in certain solvents and in aqueous suspension. A freshly prepared suspension of rotenone made by adding an acetone solution of it to water at 1:50,000 killed more than 95 percent.

The green peach aphid was used by Davidson as a test insect and referred to by Shepard (241) in 1931 (see Brevicoryne brassicae L., page 18.

Tattersfield (258) in 1932 discussed laboratory methods for evaluating insecticides. Results of tests with two samples of derris root against M. persicae are stated as follows:

> The two samples had the same rotenone content, and over a definite range of concentrations (up to 0.05 percent), expressed in terms of root, the results for equivalent concentrations do not differ by more than the experimental error, although sample F is always slightly less effective. The results are normal up to a certain concentration (0.05 percent), and then, above that strength, both samples are shown to be less effective than below it. In the case of root B, the results are scarcely significant, but in the case of root F definitely significant. Obviously two factors are working in opposite directions.

In discussing how far the factor of time should be taken into account in judging toxic effects quantitatively, Tattersfield wrote:

> If the rapidity of action had only been taken into account in the past, a number of valuable insecticides would never have come to light. There is a startling difference between the rapidity of effect of the pyrethrins on the one hand and rotenone on the other; for whereas the rapid narcosis produced by the pyrethrins may wear off at concentrations below a certain level, the narcotic effect of rotenone deepens in intensity with time.

Turner (271) in 1932 reported the results of work carried on during 1928-31, inclusive, with cube extract and with rotenone obtained from cube. Cube extract was incorporated in a sulfonated mineral oil called "oil-soluble sulfonate" by dissolving the proper amount of cube extract in benzol, mixing this with the oil-soluble sulfonate, and evaporating the benzol at low temperature. This preparation at a dilution of 1:200,000 of total extract of cube killed 37.5 percent of M. persicae. Five months later this preparation gave the same percentage of kill, indicating no decomposition of the rotenone in that time.

W. DuB. Thorne, American Vice Consul at Medan, Sumatra, reported in 1933 that the Deli Experimental Station buys derris not on a basis of rotenone content but on a basis of ether extract to combat M. persicae on tobacco. The concentrated aqueous extract is diluted 1:40 for use.

Garman (117) in 1934 reported that a commercial rotenone preparation at 1:1,000 plus bead soap at 1:1,000 gave relatively poor results against the green peach aphid.

Trappmann and Mitsche (270) in 1935 reported 100-percent mortality in 4 days of (Phorodon (Myzodes)) Myzus persicae when sprayed with a suspension of rotenone (0.15-percent rotenone) plus Turkey-red oil. The dosage was regulated to give a deposit of 0.18 mg. of rotenone per 500 cm.

Derris dust failed to give satisfactory control in the field.--Walker and Andersen (297); also reported by Cory (277) in 1935.

Deshpande (77) in 1937 reported that usually two species of aphids, Myzus persicae and (Siphocoryne indobrassicae Das) Rhopalosiphum pseudobrassicae (Davis) are found attacking cabbage and that both of them go under the common name of cabbage aphid. In 1932 Derrisol at 1:800 killed 100 percent of the aphids. Derrisol is not now manufactured, hence is no longer available.

Dust containing 0.75 percent rotenone may be used to control this insect on spinach, cabbage, and cauliflower on Long Island. It is advisable to make the application late in the afternoon or early in the evening when dew is expected.--Crosby, Chupp, and Leiby (58) in 1939.

Haude (144) in 1939 recommended cube or derris dust (0.75 percent rotenone) plus 0.5 to 1 percent of a wetter, to be applied at 30 to 50 pounds per acre with a canvas trailer when the plants are dry.

Pentalonia nigronervosa Coq.

Ocfemia (215) in 1931 wrote on bunchy-top of abaca in the Philippines and its control. This disease is caused by a virus which is spread from plant to plant by the aphid P. nigronervosa. For control the stools should be dug up, chopped in pieces, and sprayed with nicotine or derris spray. The soil around the stools should also be sprayed. Derris spray is prepared from 1 kg. of derris roots and 10 liters of water: "Pound the roots of derris thoroughly and macerate them in water over night. Strain through cloth. For use take 1 part of the infusion and dilute it with 10 parts of water."

Periphyllus lyropictus (Kess.), the Norway-maple aphid

Hamilton and Gemmell (137) in 1934 reported that in nursery tests against the Norway-maple aphid derris dust (1 percent rotenone) killed 40 percent.

Phorodon humuli (Schr.), the hop aphid

Winston (312) in 1926 reviewed information on Derrisol for the benefit of Florida citrus growers. Reference was made to its use against hop aphids in England. Derrisol should be diluted 1:800 for use against aphids.

Derris or rotenone suspensions at concentrations of 1:5,000 or 1:6,250 were effective.--DeBussy et al. (32) in 1935.

Hampp and Jehl (139) in 1938 reported that sprays of derris alone and with pyrethrum gave excellent results against hop aphids on hops in Germany. It was recommended that nicotine be used until blossom time, and derris or derris with pyrethrun from then on.

Warwick (300) in 1938 reported that in England derris products are used very effectively against the hop aphid.

Pterochlorus tropicalis Van der Goot

Neoton (derris extract in fish oil) 225 gm. plus an equal weight of soap, in 40 imperial gallons of water, killed 100 percent.--Institute of Physical and Chemical Research (162) in 1927.

Rhopalosiphum prunifoliae (Fitch), the apple grain aphid

Headlee (145) in 1926 reported that Derrisine diluted 1:100 in two tests permitted 52 and 32 percent of the eggs of (Aphis avenae F.) Rhopalosiphum prunifoliae to hatch as compared with an average of 58.8 percent in the checks.

A block of 10 young Delicious apple trees was sprayed with a mixture consisting of 3 pounds of colloidal copper fungicide, 1 pound of derris (5 percent rotenone), commercial oil emulsion to give 3 percent actual oil, and 100 gallons of water. The sprays were applied during the

last days of April, when most of the leaves were about 1/2 inch out. Subsequent observations disclosed that approximately 90 to 95 percent of the hatched aphids (Siphocoryne avenae) were dead on this block within 48 hours after spray application.--Ginsburg and Granett (124) in 1935.

[According to P. W. Mason, the aphids referred to in the two preceding paragraphs probably are R. prunifoliae.]

Rhopalosiphum pseudobrassicae (Davis), the turnip aphid; false cabbage aphid, Indian mustard aphid, or turnip louse

McIndoo, Sievers and Abbott (189) in 1919 killed 100 percent of this species in laboratory tests with derris dust.

Darley (62) in 1931 found that in tests in the field, rotenone at a concentration of 1:100,000 as a contact poison in spray form compared favorably in toxicity with nicotine at 1:10,000 and pyrethrins at 1:74,800. Penetrol at the same concentration (1:200) was used in each spray. Rotenone at 1:100,000 killed 98.5 percent of these aphids in 48 hours.

Little (183) in 1931 reported that field experiments on this species with the powdered root of [Gracca] Tephrosia virginiana showed that the plant has considerable promise as a contact spray. At 1:400 in water a spray of the powdered root of T. virginiana killed 93 percent of the turnip aphids.

Turner (271) in 1932 reported that rotenone dissolved in oil-soluble sulfonate and applied at the rate of 1 part in 40,000 gave excellent control of (Aphis) Rhopalosiphum pseudobrassicae on radishes in greenhouses. At the rates of 1:50,000 and 1:60,000 the results were not so satisfactory.

In November 1933 Allen (5) reported that at Baton Rouge, La., rotenone, in addition to killing the turnip aphid, protected the turnip plants for several days from attack by chewing insects. Derris dust diluted with tobacco dust of x-grade to 0.5 percent rotenone content, and derris dust diluted with sulfur dust to 0.5 percent rotenone content, protected plants from leaf-eating species from 6 to 8 days.

Foliafume (a pyrethrum-derris spray with spreader) at 1:400 killed 88 percent.--Penick and Company (223) in 1936.

Allen (6) in October 1934 reported that a dust containing 1 percent of rotenone gave promising results for the control of the turnip aphid on turnips and mustard. Equal parts of finely ground tobacco dust and 300-mesh dusting sulfur were used as a diluent. The author stated that the derris-root-dust mixture should be thoroughly applied in such a manner that a light coating of it reaches the undersides of the leaves. It may be applied to wet or dry plants preferably in late afternoon. Good results have been obtained by making applications immediately after rains.

The dust should be applied at the rate of 20 to 25 pounds per acre, based on 3-1/2- to 4-foot rows with two rows of plants to each field row. Ordinarily treatments should be made at 7- to 10-day intervals for best results. Under field conditions sprays have not been so satisfactory as dusts against the turnip aphid on turnip and mustard. It is difficult to reach the lice on the undersides of the leaves, especially on large plants. If a spray is preferred, a nicotine sulfate-soap solution is recommended.

The United States Department of Agriculture, Bureau of Entomology and Plant Quarantine (278) in its annual report for 1935 stated that experiments on the turnip aphid in Louisiana indicate that derris dust may satisfactorily protect the turnip crop from damage. In its annual report for 1936 the Bureau (280) stated that in tests directed against the turnip aphid in Louisiana insecticides containing rotenone, with sulfur and talc as diluents, were in general more effective in producing a satisfactory market product that were insecticides containing nicotine. In 1939 the Bur (285) reported that insecticides containing rotenone had proved effective.

Fenton (101) in 1936 referred to the report of Allen (6) and to unpublished work by Roney of Texas, who reported very good results at Dickinson with a dust containing 10 pounds of powdered derris or cube (5 percent rotenone), 15 pounds of pyrethrum dust (0.5 percent pyrethrins), and 75 pounds of 300-mesh conditioned sulfur. The dust did not cause any burn of the turnips and when applied early in the morning or late in the afternoon, when dew was present and very little wind, it controlled this insect. It was effective at temperatures as low as 45° F.

Harrison (141) in September 1936 reported the results of field tests with insecticides against the turnip aphid on Purple-top Globe turnips and Florida broadleaf mustard, at the Baton Rouge, La., laboratory, of the Bureau of Entomology and Plant Quarantine. A dust mixture containing 1 percent of rotenone, with equal parts of tobacco dust and sulfur as diluents, was superior to derris sprays, and dust mixtures containing nicotine sulfate. The dust mixture containing rotenone not only gave satisfactory reduction in the aphid population immediately after treatment but continued to inhibit the increase of aphids for a period of at least 6 days. Derris sprays ranked second in effectiveness against the aphids. A nicotine sulfate-dust mixture containing 3 percent of nicotine was effective against the aphids for a short period after application but did not afford adequate protection for so long a period as did the derris dusts or sprays.

The Texas Agricultural Experiment Station (265) in 1936 reported that for the control of R. pseudobrassicae a sulfur dust containing 0.075 percent of pyrethrins and also 0.5 percent of rotenone gave results inferior to Nicotrol (a nicotine product) at a dilution of 1:300, applied by means of a fan-shaped nozzle.

Deshpande (77) in 1937 reported that usually two species of aphids, Myzus persicae and (Siphocoryne indobrassicae Das) Rhopalosiphum pseudobrassicae, are found attacking cabbage in India and that both of them go under the common name of cabbage aphid. In 1932 Derrisol at 1:800 killed 100 percent of the aphids. Derrisol is not now manufactured, hence is no longer available.

The Louisiana Agricultural Experiment Station (184) in 1937 recommended derris diluted with sulfur, tobacco dust, clay, or talc to a rotenone content of 1 percent for the control of the turnip aphid.

The Texas Agricultural Experiment Station (266) in 1937 reported that the standard spray formula (Nicotine sulfate plus penetrol) was superior to the rotenone-pyrethrum-sulfur combination in dust form, and remained more effective for a week or 10 days after the applications were made.

Harrison (142) of the Baton Route, La., laboratory, reported in 1939 that tests with 20 different dust mixtures, involving the use of dilutions of 1.0 and 0.5 percent of rotenone with various diluents and conditioners, resulted in no significant differences in yield between the treatments. This indicates that the present standard recommendation for turnip aphid control (rotenone-dust mixture containing 1-percent of rotenone with equal parts of tobacco dust and sulfur) is not appreciably improved by the addition of any of the more common conditioning agents used in combating aphids. Conditioning agents tested were: One or 2 percent of peanut oil, 4 percent of soybean flour, and 1 percent each of peanut butter, cottonseed oil, pine oil, oleic acid, sulfonated castor oil, sodium oleyl sulfate, and an alkylated naphthalene-sulfonate.

Haude (144) in 1939 recommended cube or derris dust (0.75-percent rotenone) plus 0.5- to 1-percent of a wetter, applied at 30 to 50 pounds per acre with a canvas trailer when the plants are dry.

Rhopalosiphum subterraneum Mason

Rhopalosiphum sp. [probably R. subterraneum.]

(See reports of tests made by the South Carolina Agricultural Experiment Station (249) and Rainwater (238) under Anuraphis maidi-radicis Forbes, pp. 4-5.)

Toxoptera aurantii (Fonsc.), the black citrus aphid

Tests were made by Worsley (323) in 1934 with Derris, Tephrosia, and Lonchocarpus against citrus aphids at the East African Agricultural Research Station. Dried ground material was shaken in absolute alcohol (9 cc. alcohol for each gm. of material) for 24 hours, filtered, and brought up to 10 cc. volume per gm. of material by washing the filter with alcohol. This is called a 10-percent extract of the plant material. The method of assessing the effect of the sprays was to take 10 aphids for each trial and to examine them 24 hours after spraying. One-half percent of soap or 1 percent of saponin was added as a spreader and the spray was applied for 4 seconds from a distance of 18 inches. Tests were made with the root of Derris elliptica; the flowers, seeds, leaves, pods, stems, and roots of Tephrosia vogelii; the leaves, seeds, and roots of T. toxicaria; the leaves, seeds, and pods of T. nyikensis; the leaves, seeds, and roots of T. candida; the leaves and seeds of T. noctiflora; and the leaves and roots of 2 species of Lonchocarpus designated A and B. Extracts of Derris elliptica roots and the seeds of T. vogelii were the most toxic, killing 100 percent of the aphids.

Van der Scheer (239) in 1935 reported that rotenone-benzene emulsion (1 gm. rotenone, 20 cc. benzene, and 30 cc. water containing 0.1 to 0.15 gm. Igepon T) at a concentration of 1:5,000 gave a 100-percent kill of the black citrus aphid on tea foliage.

Worsley (324) in 1936 reported that Mundulea suberosa Benth. bark (0.9 percent rotenone) from Moa district, Tanganyika Territory, East Africa, was even more toxic than derris root (5.4 percent rotenone) to this species. Concentrations necessary to give 100-percent kill of Toxoptera aurantii were 0.06 percent for nicotine, 0.125 percent for Mundulea bark, and 0.15 percent for derris.

Trifidaphis phascoli (Pass.)

See report of tests made by the South Carolina Agricultural Experiment Station (249) and Rainwater (228) under Anuraphis maidi-radicis Forbes, p. 4.

Derris applied to the seedbed before planting, and around the plants hastened the germination of cotton by 24 hours, but did not control 3 species of root aphids of which T. phascoli causes the most severe damage.--United States Department of Agriculture, Bureau of Entomology and Plant Quarantine (285) in 1939.

Aphiidae (unidentified species)

Aphids on apple

Kopp (176) in 1924 reported that a spray consisting of 1 pound of derris powder plus 1 kg. of soap in 800 liters of water gave excellent results against apple aphids.

The Michigan Agricultural Experiment Station (199) in 1925 reported that derris sprays had given encouraging but not conclusive results against various aphids on apple.

Derris spray gives a good measure of control of aphids on apple trees in England.--Kearns, Marsh, and Pearce (168) in 1932.

These insects were killed by derris dust (1 percent rotenone).--De Bussy et al. (32) in 1935.

Aphids on beans

Plant lice on lima beans, along with the Mexican bean beetle and mildew or pod mold, are controlled by a rotenone preparation added to the bordeaux spray.--Suffolk County, N. Y., Farm Bureau (254) in 1933.

Aphids on birch

Derris, 1-1/2 pounds per 100 imperial gallons of water, with the addition of soap, was used against aphids on a cut-leaf birch but they did not appear to be affected during the first 12 hours. Two days later the tree was found to be completely free of aphids.--Kelsall et al. (168) in 1926.

Aphids on cabbage

White (304) in 1935 and again (306) in 1936 stated that tests have indicated that derris dusts may aid in the control of certain aphids that infest cabbage and related crops.

DeBussy et al. (31) in 1936 stated that aphids can be readily controlled by spraying with a suspension of derris having a rotenone concentration of 1:10,000 or by spraying with a pure-rotenone suspension containing rotenone at a concentration of 1:5,000. During 1935 deBussy and associates used derris dusting powders (0.5 percent rotenone plus 1.2 percent ether extract) against several varieties of leaf lice, including gray aphids on cabbage seed. There was no kill of these insects. From this it is concluded that in only a few cases can satisfactory results against aphids be expected when derris powder is used as a dust. Spraying with derris extracts is to be favored.

Derris dusts effective against cabbage worms do not give satisfactory control of plant lice.--Colorado Agricultural Experiment Station (50) in 1936.

The New South Wales Entomological Branch (209) in 1936 reported that, where derris dust is applied throughout the season at 7- to 10-day intervals for the control of Plutella maculipennis (Curt.), it will also check green aphid infestation but does not control the slaty-gray aphids.

Merino and Otanes (197) in 1938 recommended a derris-soap spray for the control of aphids on cabbage. Either dried or fresh derris roots may be used.

Aphids on cauliflower

Infestations of aphids in the cauliflower seedbed during July were effectively controlled by dusts containing 0.5 and 0.33 percent of rotenone. The applications were made late in the evening under calm conditions, in anticipation of high relative humidity during the night.--New York Agricultural Experiment Station (213) in 1937.

Aphids on Ceylon ironwood

Miller (201) in 1935 tried aphids on Ceylon ironwood (Mesua ferrea L.) as test insects in determining the insecticidal value of various species of derris, but they proved too susceptible and difficult to handle; 100-percent mortality was obtained each time, not only with the insecticide but also with the control fluid.

Aphids on cherry

Barfoot (12) in 1935 stated that the cherry and pear growers of the Bay district of California used several tons of cube dust for the control of aphids and other insects.

Aphids on chestnut trees

Black plant lice on chestnut trees fell off in a few minutes when sprayed with a commercial derris product [probably Nicoton].--Anonymous (1) in 1927.

Aphids on chrysanthemum

Compton (51) in 1930 recommended Derrisol for the control of aphids on chrysanthemums.

Aphids on chrysanthemum were controlled by a rotenone spray of 1:5,000 plus 0.1 percent of Agral I.--Wageningen Plantenziektenkundigen Dienst (293) in 1934.

Aphids on citrus

Symes (255) in 1924 reported that two proprietary derris extracts gave highly satisfactory results against the black citrus aphid in Rhodesia.

Winston (313) in 1926 reviewed information on Derrisol for the benefit of Florida citrus growers. Derrisol should be diluted 1:800 for use against aphids. Should a grower be spraying with lime and sulfur solution for rust mites, oil emulsion for scale, bordeaux mixture for fungus diseases, or lead arsenate for chewing insects, and any aphids be present, an addition of Derrisol 1:800 will pay handsomely, enabling this pest to be controlled with the one spraying; or if aphids are present and no other application is to be made, Derrisol mixed with water without soap will be the cheapest efficient liquid aphicide that can be applied.

Rhoads and Debusk (230) in 1931 recommended derris preparations at the rate of 1 pint to 100 gallons of water for spring applications for the control of aphids on citrus in Florida. These should be applied at the time of first flush of growth. By employing some of the more efficient spreaders (certain oxidized oil derivatives, oleates, or pine-oil soaps) the quantity of nicotine sulfate or derris compounds required for 100 gallons of spray mixture may be cut down to 1/4 pint at a 50-percent saving in cost. For the spray to be applied late in winter, 1 tablespoonful of derris compound to 2 gallons of water is recommended.

Basinger and Boyce (13) in 1936 reported that cryolite and barium fluosilicate may be combined with derris preparations for citrus aphid control. Organic compounds used alone were ineffective.

The California Fruit Growers' Exchange, Bureau of Pest Control (35), in August 1936 reported that Ortho Derris and Tox-X with from 1/2 to 2/3 percent of light medium oil have given good results against aphids.

The Leffingwell Company in 1937, in a letter to R. C. Roark, stated that Tox-X (2.5 percent rotenone plus a spreader) plus oil has given promising results against aphids on citrus in California.

Boyce and Prendergast (19) in 1938 wrote that the oil rotenone mixtures are relatively expensive when considered for the control of the red spider alone; however, when considered for the combined control of aphids, the red spider, and "off-hatch" black scale during the spring, they are very practical.

The California Fruit Growers' Exchange, Bureau of Pest Control (38, 39, 40), in 1938 recommended oil-rotenone combinations for combating the citrus aphid. A suitable spray is made from 0.5 to 0.75 gallon of light medium oil, 1 to 4 pounds (depending on brand) of rotenone powder, and water to make 100 gallons. This formula may best be used where the red spider and black scale are present along with the aphids. One of the rotenone oil sprays such as Botano-R, Tox-X, or Rotox with 0.5 percent light medium oil will control both aphids and red spiders on citrus. The rotenone-oil combinations used effectively against the red spider on oranges in the coastal Valencia area also cares for any aphids present.

Aphids on corn

Miller (202) in 1935 tried aphids on corn as test insects in determining the insecticidal value of various species of Derris, but they proved too susceptible and difficult to handle; 100-percent mortality was obtained each time, not only with the insecticide but also with the control fluid.

Aphids on currant

The currant aphid was not controlled by a dust of equal parts of derris and hydrated lime.--Kelsall et al. (170) in 1926.

Aphids on dwarf spruce

The Wageningen Plantenziektenkundigen Dienst (293) in 1933 reported that a suspension of rotenone in water (1:5,000) made by adding an acetone solution of rotenone to water and also derris powder in water 1:50 (equivalent to rotenone at 1:2,500) plus 1 percent of soap gave satisfactory control of leaf aphids on dwarf spruce in Holland.

Aphids on eggplant

The Japan Seed and Plant Company, Ltd., of Tokyo, Japan, in advertising Derri-Homi (a proprietary derris product), stated [n.d.] that the Agricultural Experiment Station of Saitama Prefecture, Japan, found that this product at about 1:320 killed 100 percent of aphids on eggplant.

Aphids on flowers and fruit

The Handelsmuseum of the Koloniaal Instituut of Amsterdam (8) in 1930 reported derris to be an exceptional material for control of aphids on flowers and fruit in the greenhouse.

Fryer (108) in 1926 referred to the use of Derrisol in England for the control of aphids on fruit.

Aphids on goldenrod

A red aphid on goldenrod was not controlled by a dust of equal parts of derris and hydrated lime.--Kelsall et al. (169) in 1926.

Aphids on head lettuce

The aphids that could be reached were killed by spraying with rotenone at 1:5,000. It is impossible to reach all the aphids conveniently, therefore the results remained incomplete.--DeBussy, et al. (32) in 1935.

Aphids on hops

Fryer (108) in 1926 referred to the use of Derrisol in England for the control of aphids on hops.

Aphids on Japanese maple

The Wageningen Plantenziektenkundigen Dienst (292) in 1933 reported that a suspension of rotenone in water (1:5,000) made by adding an acetone solution of rotenone to water, and also derris powder in water, 1:50 (equivalent to rotenone at 1:2,500), plus 1 percent of soap gave satisfactory control of leaf aphids on Japanese maple in Holland.

Aphids on lotus

The Japan Seed and Plant Company, Ltd., reported [n.d.] that at about 1:190 Derri-Homi killed 100 percent of aphids on lotus at Saitama Prefecture. According to the manufacturers, this product contains derris extractives and spreading and sticking agents.

Aphids on nasturtium

Fulmer (113) in 1930 wrote that the nasturtium aphid can be effectively controlled by spraying with derris powder, 5 pounds per 100 imperial gallons.

Aphids on ornamental cherry

The Wageningen Plantenziektenkundigen Dienst (292) in 1933 reported that a suspension of rotenone in water (1:5,000) made by adding an acetone solution of rotenone to water and also derris powder in water, 1:50 (equivalent to rotenone 1:2,500) plus 1 percent of soap gave satisfactory control of leaf aphids on ornamental cherry in Holland.

Aphids on ox-eye daisy

The Wageningen Plantenziektenkundigen Dienst (292) in 1933 reported that derris powder (2 percent rotenone) when added to 50 parts of 1 percent soap solution (1 part rotenone to 2,500 parts water) and also a suspension of rotenone in water (1:5,000) made by adding an acetone solution of rotenone to water gave satisfactory control of leaf aphids on ox-eye daisy in Holland.

Aphids on peanut

Miller (201) in 1935 tried aphids on peanut as test insects in determining the insecticidal value of various species of derris but they proved too susceptible and difficult to handle: 100-percent mortality was obtained each time, not only with the insecticide but also with the control fluid.

Aphids on pear

Neoton, 110 gm. plus 450 gm. of soap in 40 imperial gallons of water, killed 100 percent.--Institute Physical and Chemical Research (162) in 1927.

Aphids on pear were controlled by a rotenone spray 1:5,000 plus 0.1 percent Agral I.--Wageningen Plantenziektenkundigen Dienst (293) in 193

Aphids on plum

At Saitama Prefecture, Japan, Derri-Homi at about 1:476 killed 100 percent of aphids on plum trees, according to the Japan Seed and Plant Company, Ltd. [n.d.].

Neoton, 1 pound in 60 imperial gallons of water, killed 100 percent; 1 pound in 100 gallons killed 99.1 percent.--Institute Physical and Chemical Research (162) in 1927.

Aphids on plum were controlled by a rotenone spray 1:5,000 plus 0.1 percent Agral I.--Wageningen Plantenziektenkundigen Dienst (293) in 1934.

Aphids on raspberries

Kearns and Marsh (182) in 1937 reported that derris spray (0.004 percent rotenone) is preferable to derris dust (0.18 percent rotenone), as it provides a control for aphids on raspberry as well as for the raspberry beetle.

Aphids on rose

The Saitama Prefecture, Japan, Experiment Station reported that at about 1:238 Derri-Homi killed 100 percent of aphids on rose tree.--Japan Seed and Plant Company, Ltd., in advertising literature [n.d.].

Rosebush aphids were quickly killed by a spray of a commercial derris product [probably Neoton].--Anonymous (1) in 1927.

Cory (54) in 1938 issued a schedule of treatments for the control of rose pests. Rotenone dust is used for the control of aphids but is not so effective as nicotine dust.

Hamilton (136) in 1938 reported cube and derris powders (4 percent rotenone and 16 to 18 percent total extractives) applied as a spray at the rate of 4 pounds per 100 gallons, with the addition of 4 pounds of rosin-residue emulsion, gave a good kill of aphids on roses.

Dusts containing 0.75 percent rotenone are satisfactory.--Haude (145) in 1939.

Aphids on sesame

Van der Scheer (239) in 1935 reported that rotenone-benzene emulsion (1 gm. rotenone, 20 cc. benzene, and 30 cc. water containing 0.1 to 0.15 gm. Igepon T) at a concentration of 1:5,000 gave good control of the sesame leaf aphid.

Aphids on soybean

Miller (201) in 1935 tried aphids on soybean as test insects in determining the insecticidal value of various species of Derris but they proved too susceptible and difficult to handle; mortality was 100 percent in each test, not only with the insecticide but also with the control fluid.

Aphids on spirea

The Ohio Agricultural Experiment Station (216) in 1922 reported that 80 percent of the aphids on Spirea vanhouttei were killed by Derrisene at 1:1,200.

Aphids on strawberry

Brooks, Watson, and Mowry (30) in 1932 reported that derris preparations may be used instead of nicotine sulfate for spraying aphids attacking the above-ground parts of strawberry plants.

Aphids on tobacco

Westerman (303) in 1901 recommended a solution of derris root as a spray for use against lice on tobacco on the east coast of Sumatra.

Hollrung (148) in 1923 wrote that in Sumatra the following preparation had given good results against leaf lice on tobacco: 1-1/2 kg. of fresh tuba root mashed in 20 liters of water and diluted with an equal volume of water for use.

Fulmek (109, 110) in 1924, in discussing insecticides for use against tobacco pests in Sumatra, listed akar tuba (derris) as a contact insecticide. The addition of 0.3 to 0.5 percent of soap to solutions of derris is advised, and akar tuba is recommended for leaf lice on tobacco at the rate of 1 kg. in 100 liters of water to which 0.5 kg. of soap is added. Fulmek (111) in 1925 gave directions for spraying against leaf lice with derris. The formula is 1 kg. of akar tuba (derris), 100 liters of water, and 300 gm. of soap. In 1927 Fulmek (112) reported the use of a 1-percent water extract of the roots of Derris elliptica for the control of plant lice on tobacco in Sumatra.

Bourcart (17) in his book, "Insecticides, Fungicides, and Weed Killers," stated that a spray containing 1 pound of derris, 10 imperial gallons of water and 5 ounces of soft soap is effective against aphids infesting tobacco in

Sumatra. The derris roots, which may be dry or fresh, are cut into small pieces, placed in a little water, and then pounded into a paste, which is diluted with a gallon of water and left standing overnight in a wooden vat. The dregs are then pressed, and all the fluid is strained through a cotton cloth. The resultant concentrate is a milk-white solution, which keeps for a few days only. It is diluted with 9 parts of water for spraying. About 16 imperial gallons of solution are needed for 1,000 tobacco plants that have been from 25 to 30 days in the field. Twice this quantity is needed for full-grown plants. If derris roots are to be stored they must be kept dry.

The Deli Proefstation at Medan (67) in 1926 reported that akar toeba extract gave excellent control of aphids on tobacco. Some difficulty was experienced in obtaining a uniform extract, so this was prepared with the machinery of the Delische Kleiindustrie. Formalin was added, to a concentration of 2.5 percent as a preservative. The proefstation (68) in 1927 reported that derris extracts (suspensions of the milky sap in water), supplied by the proefstation to tobacco growers, retain their toxicity for at least 1 year when kept in well-closed barrels. Decomposition occurs in open vessels and in those not hermetically closed. The suspension becomes gray or nearly black, develops the odor of hydrogen sulfide, and loses effectiveness. Contact with iron is stated to be undesirable.

Rodecker (229) in 1926 called attention to the large-scale use of aqueous derris extract in Sumatra for destroying aphids on tobacco.

W. A. Foote, American Consul at Medan, Sumatra, in May 1929 submitted a report to the United States Bureau of Foreign and Domestic Commerce on the use of derris in fighting tobacco plant pests. Against tobacco lice an aqueous extract of fresh derris root at 1:40 is more effective but slower than 3 percent of nicotine with soap. In 1931 Foote (106) reported that a liquid contact insecticide prepared from derris was used against the tobacco aphid in Sumatra. Hand pumps were more effective than power sprayers in applying it.

Braddock (20), American Vice Consul at Medan, Sumatra, in 1930 reported that derris is used on practically all the tobacco estates to combat aphids. The insecticide is prepared by the Deli Proefstation and supplied to the planters at cost. The station supplied the following quantities (expressed in liters) of derris extract to the tobacco growers: In 1926, 35,000; in 1927, 77,000; in 1928, 56,000; and in 1929, 65,000.

The Wageningen Plantenziektenkundigen Dienst (292) in 1933 reported that derris extract had long been used for the control of leaf aphids in the Deli tobacco fields, and for some time had been a constituent of proprietary extracts.

Hendren (146), American Trade Commissioner at Batavia, Java, in 1931 reported that tuba (derris) extract is an excellent remedy for aphids on tobacco in Java.

Aphids on tomato

Aphids on tomato plants were killed by Cubor 75 dust (0.75 percent rotenone), and derris-gypsum dust (0.4 percent rotenone).--Herman and Hockey (147) in 1936.

Rotenone dust is ineffective.--Haude (144) in 1939.

Aphids on viburnum

Aphids on viburnum were controlled by a rotenone spray 1:5,000 plus 0.1 percent of Agral I.--Wageningen Plantenziektenkundigen Dienst (293) in 1934.

Aphids on violets

Compton (51) in 1930 recommended Derrisol (1 ounce to 4 or 5 gallons of water) for the control of aphids on violets and pansies.

Aphids on white pine

Hamilton (136) in 1938 reported that cube and derris powders (4 percent rotenone and from 16 to 18 percent total extractives) applied as a spray at the rate of 4 pounds per 100 gallons, with the addition of 4 pounds rosin-residue emulsion, gave a poor kill of aphids on white pine.

Aphids in general

Epp (95) in 1851 described the use of derris as an insecticide in Banka (an island lying east of Sumatra). It was used for destroying tree lice. For this purpose the root was cut into pieces, soaked for some days in water, and sprinkled on the plants.

Wahl and Muller (294) in 1915 reported that the derris preparations, Contraphin and Katakilla are effective against plant lice at concentrations of 1:250 and 1:200, respectively.

The Annual Report of the Bureau of Entomology, United States Department of Agriculture for 1919 (275) stated that if derris can be obtained in sufficient quantities it will prove an important addition to our list of substances that kill soft-bodied insects, such as plant lice.

The California Agricultural Experiment Station (33) in its annual report for 1922-23 stated that Derrisine (an extract of derris) was unsatisfactory as an aphicide. Dilutions of 1:300 were 68 percent efficient, whereas 1:500 gave a control of but 50.5 percent.

An undiluted powdered derris root when dusted on aphids was 100 percent effective in 8 hours.--DeOng and White (75) in 1924.

The Federated Malay States Department of Agriculture (99) in 1924 recommended for sucking insects a spray made by adding 8 to 10 pounds of derris root and 4 pounds of soap to 100 imperial gallons of water.

McIndoo and Sievers (188) in 1924 reported numerous tests of cube and derris in the form of dusts, and alcoholic and aqueous extracts, against unidentified aphids designated as Aphis spp. A, B, C, D, and E. In general these preparations were highly effective.

Carlos (47) in 1926 reported that derris as a contact or external poison, with or without the use of soap as a spreading agent, had been found effective against aphids in as low a dilution as 1 pound of root to 400 gallons of water, which represents a proportion of 0.025 percent. Aphids are some of the chief insect pests which can be easily exterminated by the application of insecticides containing derris or its products. One interesting property of derris as a killing agent is that the effect lasts for a considerable time. Leaves sprayed with a solution containing derris preparations will remain poisonous to insects for many days.

William Cooper and Nephews, in the February 1926 issue of Florida Entomologist, advertised Derrisol, stating that it was a new aphid spray having no odor, being nonpoisonous and pleasant to use, did not require soap, could be mixed with other sprays, and could be used with hard or soft water.

The Deli Proefstation (68) in Medan, Sumatra, in 1927 reported that derris was satisfactory for the control of aphids, but Derrisol was found ineffective at 1:400, although it was claimed to be effective at 1:800.

Neoton at 110 gm. plus 220 gm. of soap per 40 imperial gallons killed 100 percent of arrowhead aphids, and at half this concentration nearly all were killed. Neoton at 1/2 pound per 40 imperial gallons of water killed 100 percent of unidentified aphids.--Institute Physical and Chemical Research (162) in 1927.

McDaniel (186) in 1928 recommended Derrisol as a contact spray for use against aphids and Metcalf and Flint (198) in 1928 summarized current information on derris, which they recommended for aphid control.

Dammerman (61) in his book, "The Agricultural Zoology of the Malay Archipelago," published in Amsterdam in 1929, mentions derris as having come much into use as an insecticide.

> To prepare the insecticide the roots of derris are powdered, and the product is now on the market. It is not of such a high value as was first expected, but being cheap in our region it may be found a useful substance. For making a spray, fresh roots are macerated with water, as a rule a 1-percent solution of derris is found most satisfactory; a stock solution is made by placing 1 kg. of comminuted roots in 10 liters of water in a wooden vessel, the solution standing over for 1 night; the stock solution after being strained through a cloth is diluted 1:10. But as it is impossible to ascertain the exact content of the toxic substance in a solution this insecticide is somewhat unreliable.

In Deli, Sumatra, a 1-percent solution, to which is added 0.5 percent of soap, is used successfully against aphids. The liquid, however, keeps its efficiency for a few days only. The Dutch proprietary insecticide known as Phytophiline probably also contains derris, but it is far too expensive.

According to an anonymous writer (2) in 1930, a spray containing as little as 0.025 percent of derris extract (obtained by extracting with water) is effective as a contact poison for aphids.

Corbett (52), entomologist for the Federated Malay States Department of Agriculture, in 1930 reported that plants regularly sprayed with tuba at the rate of 1 pound to 10 imperial gallons of water will be kept comparatively free from aphids and similar insects.

Peyer (228) in 1930 recommended a spray made by adding 1 kg. of derris powder and 1/2 kg. of soap in 100 kg. water for control of sucking insects. Schmitt (240) in 1930 in a discussion of derris stated that different kinds of leaf lice were controlled by derris dust or by derris-extract spray.

The Wageningen Plantenziektenkundigen Dienst (291) in 1931 reported that derris was unsatisfactory for the control of leaf lice on various plants in the field at Aalsmeer.

Betrem (14) in 1931 compared imported ground derris with nicotine as a control for black aphids in the entomological laboratory in Wageningen, Holland. No details were given, but the results were very disappointing. The author pointed out that this was probably due to poor quality of sample, and discussed the need of judging derris by its rotenone content, and not by its total ether extract, because there is no correlation between them, according to figures from Spoon. He also discussed briefly the methods of using derris, the advisability of adding soap, and the manner in which it kills insects. Derris is entirely harmless to plants, whereas nicotine sometimes burns. Betrem believes that derris is the coming insecticide for greenhouse use.

Katakilla should be applied as a spray at 0.5 to 0.75 percent concentration against aphids.--Deutscher Pflanzenschutzdienst (78) in 1931.

Andries (10) in 1932 recommended Derrisol and Katakilla for use against "green fly" (aphids).

Goff and Tissot (129) in 1932 reported that extracts of derris are scarcely more effective than nicotine against aphids, and as there is little difference in cost their use has not become general. Like the pyrethrum sprays, the derris extracts are somewhat more effective than nicotine against some of the larger, more resistant insects. Certain activators, such as sodium and potassium oleates, pine tar soaps, and a sulfonated oil product, increase the effectiveness of the derris sprays slightly.

Ginsburg (121) in 1933 stated that when only aphids are present, 1/2 pint of an acetone extract of derris (5 percent rotenone, 20 percent total extractives) to 100 gallons of water, containing about 0.25 percent of coconut oil soap, is sufficient.

Gnadinger (128), in the first edition of his book, "Pyrethrum Flowers," concluded that the only practical advantage in adding rotenone to pyrethrum sprays is to increase the toxicity to aphids. Unpublished work by Ginsburg is cited which indicates that rotenone is more toxic than the pyrethrins to aphids.

Hamilton (136) in 1933 stated that derris and cube powders have a distinct repellent effect and some fumigating effect against certain insects, such as plant lice.

Spoon (250) in 1933 reported sprays of derris powder with half its weight of soap and rotenone suspensions made by pouring an acetone solution into water plus 0.1 percent Agral or 0.05 percent Lethalate as a spreader (rotenone concentrations 1:2,500 and 1:5,000, respectively) to be effective against lousi aphids in Holland.

Benkert and Company, Inc., of New York, N. Y., in March 1934 stated in advertising literature that derris dust is effective against plant lice.

An alcoholic extract of derris plus soap was effective against plant lice.--Bock (16) in 1934.

The Rubber Service Laboratories, Inc. (238), in 1934 reported that a spray containing 7 parts of derris resin, 33 parts of dry Aresco, and 60 parts of pine oil (or oleic acid) is effective against aphids at 1:800.

The Alabama Polytechnic Institute (3) in 1935 reported that derris dust alone is not very effective in controlling plant lice but when mixed with sulfur is of some value in repelling these insects.

DeBussy et al. (32) in 1935 reported that aphids can readily be controlled by spraying with a suspension of derris having a rotenone concentration of 1:10,000 or by spraying with a pure-rotenone suspension containing rotenone at a concentration of 1:5,000. During 1935 deBussy and associates used derris dusting powders against green and black aphids with the following results:

Host plant	Strength of dusting mixture: Rotenone	Ether extract	Mortality
	Percent	Percent	Percent
Green aphids:			
Rose	0.25	0.6	59
Do	1.50	1.2	74
Do	1.00	2.4	89
Plum	.50	1.2	0
Black aphids:			
Garden beans	.50	1.2	70
Cherry	1.00	2.4	67
Poppy	.50	1.2	5
Dahlia	.50	1.2	2

The authors concluded that satisfactory results by dusting with derris powder against aphids can be expected in only a few cases. Spraying with derris extracts is to be favored.

Van der Laan (177) in 1935 reported dihydrorotenone to be less toxic than rotenone to red and green aphids.

Miles and Miles (200) in 1935 discussed insect pests of glasshouse crops. They stated that aphids can be destroyed with 1 pound of derris powder per 100 imperial gallons of water, and about 6 gallons per 50 square yards of crop should be applied as a drench.

The New Jersey Agricultural Experiment Station (206) in 1935 reported that derris and cube are practically equal in their toxicity to aphids, provided they contain about the same amounts of rotenone and total extractives.

The Rubber Service Laboratories Company, Inc. (238) (a subsidiary of Monsanto Chemical Company), in 1935 recommended a mixture of 7 parts of derris resin, 33 parts of dry Areskap, and 60 parts of either pine oil or oleic acid at 1:800 for aphids.

Van der Scheer (239) in 1935 reported that rotenone-benzene emulsio (1 gm. rotenone, 20 cc. benzene, and 30 cc. water containing 0.1 to 0.15 gm. Igepon T) at a concentration of 1:5,000 gave good control of the green aphid.

The Deli Experiment Station, as reported by the Koloniaal Instituut of Amsterdam (174, 175) in 1936, found undiluted ground Tephrosia toxicari root to have slight effect on leaf aphids, but derris was much more effective.

Aphids in general are sensitive to derris.--Van der Laan (178) in 1936.

Van der Vecht (287) in 1936 wrote that for the control of Aphididae [=Aphiidae] spraying with rotenone suspensions containing 0.005 to 0.02 percent of rotenone can be recommended. Adding a spreader improves the effectiveness of the spray.

The American Association of Economic Entomologists, Eastern Branch (7), in 1937 published "Entoma," a directory of insect-pest control. Information on the chemistry, stability, and insecticidal uses of derris and cube is given and the principal manufacturers of derris and cube products are listed. Plant sprays containing 1 percent of rotenone and 4 percent of total acetone extractives of derris root will give good kill of plant lice at a dilution of 1 part to 800 parts of water. This gives a dilution of rotenone equal to 0.00125 percent.

Bourne and Boyd (18) in 1937 recommended rotenone sprays for combating plant lice in the home garden.

Dibole (79) in 1938 stated that nicotine sulfate is better than derris or pyrethrum for killing most plant lice.

Hamilton (156) in 1938 reported tests of cube and derris powders (4 percent rotenone and 16 to 18 percent total extractives) applied as a spray at the rate of 4 pounds per 100 gallons, with the addition of 4 pounds of rosin-residue emulsion. Woolly aphids (various species of Homoptera, Aphiidae) on beech, elm, larch, and white pine trees were not satisfactorily controlled.

Aphids can be controlled by sprays of derris powder suspended in water containing even less than 0.02 percent of rotenone.--Van der Vecht (289) in 1938.

Zaaijer (325) in 1939 referred to Munduloa suberosa (rotenone 5.4 percent) as an excellent insecticide for the control of aphids.

Dibble, of the United States Department of Agriculture's Extension Service, in a "Bug Flash" in 1940 reported that rotenone (derris-cube) dusts are often satisfactory, although aphids still respond best to nicotine sulfate plus hot soapy water.

Cercopidae

Aphrophora permutata Uhl., strawberry spittle bug

Edwards (93) in 1936 recommended powdered derris or cube diluted to 0.5 percent of rotenone with diatomaceous earth for the control of spittle bugs on strawberries in Oregon. An application should be made 18 days after the first nymphs appear, and 2 weeks later a second application should be made. About 150 pounds of dust per acre should be used. Hydrated-lime dust containing 2 percent of nicotine is effective but pyrethrum is ineffective, giving from 30- to 50-percent control.

Haude (144) in 1938 recommended a dust containing 0.5 percent of rotenone.

Clastoptera sp., cranberry spittle insect

A spray of 5 pounds of derris powder (4 percent rotenone) and 4 pounds of fish-oil soap in 100 gallons of water, applied at the rate of 400 gallons per acre on June 16, gave a poor kill of the nymphs in their

spittle; but 6 pounds of derris powder (4 percent rotenone) and 4 pounds of fish-oil soap in 100 gallons of water, applied at the rate of 400 gallons per acre, gave a fair kill; and 8 pounds of derris powder (4 percent rotenone) and 3 pounds of fish-oil soap in 100 gallons of water, used at the rate of 400 gallons per acre on June 16, killed nearly all the nymphs. This last spray seems to compete on even terms with nicotine sulfate in both cost and effectiveness as a treatment for this pest, and, as the cost of derris is in time likely to fall much more than that of nicotine sulfate, it should, perhaps, be preferred.--Massachusetts Agricultural Experiment Station (194) in 1937.

Philaenus leucophthalmus (L.)(P. spumarius (L.)), spittle bug

Adults are only slightly sensitive to derris.--DeBussy et al. (30) in 1936.

Edwards (93) in 1936 recommended a dust containing 0.5 percent of rotenone (see also under Aphrophora permutata Uhl.).

This insect on carnations and strawberries is repelled by a proprietary dust containing 12 percent of cube of 6 percent rotenone content, according to a letter from Etablissements Potenia to R. C. Roark in 1938.

Philaenus leucophthalmus falleni (V.D.) (P. spumarius falleni V.D.)

Philaenus leucophthalmus gibbus (Fall.) (P. spumarius gibbus Fall.)

Philaenus leucophthalmus ustulatus (Fall.) (P. spumarius ustulatus Fall.)

Hanson and Webster (140) in 1938 recommended a dust containing 0.5 percent of rotenone for the control of these spittle bugs on strawberries.

Cercopidae (unidentified species)

Massachusetts State College in its 1937 insect and disease control chart showed the use of 8 pounds of derris powder (4 percent rotenone) plus 2 pounds of soap in 100 gallons water on June 13 to 15, for spittle insects on cranberries.

Smith (245) in 1940 reported that rotenone dust was being used in Skamania County, Wash., for the control of spittle bugs.

Chermidae

Chermes abietis L., eastern spruce gall aphid

Gambrell (115) in 1931 reported that (Adelges) Chermes abietis is an important enemy of Norway spruce in New York nurseries. Miscible oils and oil emulsions have given good control but have injured some trees. Lime sulfur 1:40 gave 100-percent control; nicotine 1:800 with 5 pounds of laundry soap per 100 gallons or with Penetrol 1:200 gave 99.9-percent control; 5 pounds of laundry soap per 100 gallons alone gave 96.16-percent control. Derrisol 1:800 gave 54.72-percent control. In no case was there any foliage injury.

Rotenone in oil emulsified in water with powdered milk (rotenone 1:25,000; oil 1.0 percent) killed 100 percent of the overwintering females of this species, but the check oil did likewise.--Turner (271) in 1932.

Chermes coolgyi Gill.

Chermes sp.

The eggs of (Adelges) Chermes on pine were not killed by spraying with a suspension of rotenone in water (1:20,000).--Davidson (33) in 1930.

Derris or rotenone suspensions were ineffective.--DeBussy et al. (32) in 1935.

Not affected by derris.--Van der Laan (178) in 1936.

Kelsall et al. (169) in 1926 reported that derris dust had apparently no effect on Chermes.

Cicadellidae

Empoasca fabae (Harr.), potato leafhopper, bean leafhopper

De Long (72) in 1926 reported that a commercial derris product diluted 1:250 proved unsatisfactory against the potato leafhopper.

Benkert and Company, Inc., New York, N. Y., in March 1934 stated in advertising literature that derris dust is effective against bean leafhoppers.

Turner (275) in 1935 reported that three applications of derris dust containing 0.4 percent of rotenone reduced the injury caused by the bean leafhopper.

The Massachusetts Agricultural Experiment Station (193) in 1936 reported that Cubor and Kubatox (0.5 percent rotenone), each plus bordeaux 5-5-50, increased the yield of potatoes, because of leafhopper control.

Manschke (191) in 1937 reported that 94 percent of leafhoppers on beans were killed by a spray consisting of 2 pounds of derris powder (4 percent rotenone) per 100 gallons of water plus about 2 pounds (dry basis) of coconut-oil soap. Rotenone preparations were effective, according to the Massachusetts Agricultural Experiment Station (194) in 1937.

Derris dusts have given satisfactory results.--New Jersey Agricultural Experiment Station (207) in 1937.

F. W. Poos, in quarterly reports to the Division of Cereal and Forage Insect Investigations, of the Bureau of Entomology and Plant Quarantine, states that in 1936 and 1939 he tested rotenone-sulfur dust for the control of the potato leafhopper. This dust applied three

times to peanut vines increased the yield of peanuts 44.4 percent and was superior to bordeaux and pyrethrum-sulfur dusts. On alfalfa the tests were not conclusive because of dry weather, but the rotenone-sulfur dust was inferior to the pyrethrum-sulfur dust. The treated alfalfa was greener than the untreated.

Sleesman (243) gave the following data on the relative populations of leafhopper nymphs on potatoes receiving various spray and dust treatments at McGuffey, Ohio, in 1935. The numbers given are averages of five replications.

Treatment	Leafhopper nymphs Number
Sulfur-lime 90:10	6
Sulfur-derris (0.024 percent rotenone)	13
Sulfur-pyrethrum (0.05 percent pyrethrin)	8
Sulfur-pyrethrum (0.0125 percent pyrethrin)	11
Sulfur-pyrethrum (0.00625 percent pyrethrin)	10
Bordeaux 4-6-50	6
Bordeaux 8-4-50	8
Bordeaux 12-4-50	10
Copper-lime dust 20:80	20
Unsprayed	81

Smith (244) in 1937 reported that derris powder (4 percent rotenone) at 2 pounds per 100 gallons of water plus about 2 pounds (dry-basis of coconut-oil soap reduced the leafhopper population on beans 94 percent 72 hours after spraying.

Turner (274) in 1937 reported that a derris-clay dust (rotenone 0.6 percent) was not effective against the potato leafhopper on dahlias.

Howard (149) reported that in 1938 sulfur and sulfur-pyrethrum dusts gave the best control of the potato leafhopper on beans in Ohio. Derris sprays were comparatively ineffective. When used with peanut oil or pine oil the effectiveness of the derris sprays was increased, but peanut oil caused a yellowing of the bean leaves and subsequent defoliation and, although pine oil caused less injury to the bean foliage, it appeared to be too injurious to be recommended for general use.

Skaptason (242) in 1938 recorded some comparisons of dusts for potato leafhopper control on Long Island, when the insects were unusually abundant. The dusts were applied at the rate of 35 pounds per acre per application with an 8-row Messenger duster mounted on the draw bar of an Oliver tractor and operated by a power take-off. The Cobbler variety was dusted five times and the Green Mountains six times during the growing season. All the materials used were prepared in a Bean self-mixing duster just prior to each application. Two preparations contained rotenone: (1) A mixture of 15 pounds of root of 5 percent rotenone content with 85 pounds of Bancroft clay, and (2) a mixture of 10 pounds of pyrethrum, 15 pounds of rotenone-bearing root, 37.5 pounds of Bancroft clay, and 37.5 pounds of dusting sulfur. On cobblers, rotenone was rather ineffective in the control of leafhoppers, and the plants receiving this treatment died about 4 or 5 days after the check vines, at which time they also showed 100-percent hopperburn.

The plants dusted with the 3-Way mixture consisting of pyrethrum, rotenone, and sulfur outyielded all the others, both in total yields and with highly significant differences as regards first-size potatoes. These materials used separately as dusts gave increases in yield over the undusted ones, but these were large enough to be significant for first-size potatoes only with pyrethrum and rotenone. Perhaps the simplest hypothesis to account for the success of the 3-Way mixture is that the effect of these different materials is independent and additive; therefore, pyrethrum when used alone increased the yield of first-size potatoes, as compared with the undusted, by 37.63 bushels in the acre, the rotenone by 26.25 bushels, and the sulfur by 14 bushels, making a total of 77.88 bushels. This is not significantly different from the 93.38 bushels on each acre-increase produced by the combination mixture of these three materials. The arrangement of the experiment did not permit an evaluation of the insecticidal effects of the Bancroft Clay. On Green Mountain potatoes both copper-lime and the 3-Way dust markedly reduced the numbers of leafhoppers. The untreated vines showed 100-percent injury by hoppers, while plants dusted with copper-lime showed only 25-percent injury; however, the plants treated with the 3-Way mixture showed only 10 percent injury on the same date.

The final results show the highest yields from plants dusted with the 3-Way mixture, where leafhoppers were best held in check. At the peak of leafhopper infestation there were 58 hoppers per plant on the plants treated with copper-lime, whereas the 3-Way mixture had reduced the infestation to 18 on each plant. As no late blight occurred in these plots, the higher yield obtained from the 3-Way mixture compared with the copper-lime dust may have been due to the control of some insects other than leafhoppers, although no appreciable numbers of other species were apparent, or to the stimulative action of pyrethrum. In 1936 on this same field a reduction in yield of 60 bushels on each acre resulted from the use of bordeaux mixture. The results of Skaptason (242) are referred to in Brimstone Brevities (321); and Haude (144) in 1939 recommended the 3-Way mixture for the control of the potato leafhopper.

Howard (150, 151) of the Columbus, Ohio, laboratory of the Bureau, reported in February and March 1939 that in comparing the efficiency of several dust mixtures and sprays against Empoasca fabae on beans during the course of experiments in Ohio in 1938, it was shown conclusively that dusts of undiluted sulfur or a dust mixture made up at the rate of 90 pounds of sulfur and 10 pounds of pyrethrum containing 0.9 percent of total pyrethrins gave best results in controlling this pest. Sprays containing basic copper arsenate, basic copper sulfate, sulfur nitride, and derris (0.015 percent rotenone) were each ineffective. The addition of peanut butter [not peanut oil] to derris-dust mixtures increased their effectiveness. These mixtures were not so efficient as undiluted sulfur or the sulfur-pyrethrum-dust mixture. Pine oil also increased the effectiveness of derris spray but appeared to be too injurious to bean foliage to be recommended for general use.

Empoasca maligna (Walsh), apple leafhopper

Metcalf and Flint (198) in 1928 summarized current information on derris. Derris sprays are effective in killing the young nymphs of apple leafhoppers.

The Idaho Agricultural Experiment Station (159) in its annual report for 1932 stated that E. maligna is an important pest of the apple in southwestern Idaho. Among the materials tested and found satisfactory was Cubor (pyrethrum and rotenone).

Erythroneura pallidifrons (Edw.), glasshouse leafhopper

Wilson (310) in 1938 reported that eradication of the glasshouse leafhopper from heavily infested greenhouses is difficult. It is not controlled by repeated fumigation with nicotine or with hydrocyanic acid gas at concentrations suitable for houses of mixed plants, and both adults and nymphs are very resistant to sprays. The best control is obtained by dusting with nicotine, but the dust renders the foliage unsightly for some time. Sprays containing derris, pyrethrum extract, or eucalyptus oil are much less effective.

Erythroneura comes auct., not Say, grape leafhoppers

Eyer (97) in 1927 reported that Derrisol at the rate of 1 pint per 100 gallons killed 100 percent of the nymphs of the grape leafhopper, (Typhlocyba) Erythroneura comes. Combined with bordeaux mixture 8-8-100, it killed 98 percent of the nymphs. Foliage caged 5 days after spraying with Derrisol, 1 pint to 100 gallons, indicated approximate control of 98 percent, and the same combined with an 8-8-100 bordeaux gave a control of 96 percent. As an ovicide Derrisol was not so effective as pyrethrum-soap emulsion.

Runner, at the 1930 Codling Moth Conference of the United States Department of Agriculture (276), reported a commercial derris extract at 1:800 to be effective against grape leafhopper nymphs but not against the eggs.

A suspension of rotenone in water at 1:100,000 killed 100 percent.--Davidson (63) in 1930.

Used as a test insect by Davidson and Jones (65) in 1931 in studying the loss of toxicity suffered by rotenone in certain solvents and in aqueous suspension. In the field a suspension of rotenone in water 1:100,000 killed 94.2 percent of grape leafhopper nymphs.

Currie (59) in 1934 reported that in the Fresno, Calif., area a rotenone-sulfur dust was compared with a nicotine dust against the grape leafhopper. One pound of rotenone [derris] was mixed with 8, 10, or 12 pounds of sulfur. The dusts were applied at the rate of 20 pounds per acre with a hand duster during very windy weather. At first the nicotine mixture showed the quickest and best results, but later there

was little difference in any of the test plots. On another ranch one application of 25 pounds per acre of a derris-dust mixture gave 99-percent control of hoppers.

Hamilton and Gemmell (137) in 1934 compared the effectiveness of derris, pyrethrum, and hellebore powders against different insects. Dusts containing derris root powder (air-floated, 4 percent rotenone), pyrethrum powder (1.16 percent pyrethrins), mixtures of these two, and hellebore powder (0.8 percent active principle) were tested. Inert clay was used as a diluent. In field tests against the grape leafhopper, derris powder, pyrethrum powder, and mixtures of the two gave satisfactory control when dusted either by hand or by machine. Applications with the power duster, at the rate of 100 pounds per acre, showed that dusts containing derris powder equivalent to 0.5 percent of rotenone were nearly as effective as those containing 1.0 percent of rotenone. Hellebore was ineffective against the grape leafhopper. Heavy applications of a dust containing 1.5 percent of nicotine knocked down the grape leafhoppers but did not kill them, and all stages recovered in 1 to 2 hours.

The Idaho Agricultural Experiment Station (160) in 1936 reported that cube-kaolin dust (0.2 percent rotenone) was effective against this insect. One thorough dusting of Virginia Creeper killed most of the nymphs and adults of the grape leafhopper and a second dusting 10 days later produced complete control. Two dustings 10 days apart controlled this insect on grapes.

Foliafume (a pyrethrum-derris spray with spreader) at 1:400 killed 95 percent in 48 hours.--Penick and Company (223) in 1936.

Stearns, Haden, and Williams (252) in 1936 reported that Cubor (a rotenone and pyrethrum liquid spray) at 1:400 or 1:800 gave adequate control of Erythroneura sp. in vineyards in Delaware.

The Idaho Agricultural Experiment Station (161) in 1937 reported that a kill of 94.31 percent of the grape leafhopper was obtained with one spray containing 0.49 percent of nicotine sulfate and 0.63 percent of summer oil. Better and more lasting results were obtained with this combination than with derris or cube powder in either dust or liquid form or with pyrethrum spray. Derris as a spray was more effective than as a dust.

Parks and Fierstorff (219) in 1938 recommended a 0.75 percent rotenone dust for the control of leafhoppers on grapes.

Eupteryx flavoscuta var. nigra Osb.

McBride (185) in 1926 reported tests with insecticides against a leafhopper, Eupteryx flavoscuta var. nigra Osb., attacking the leather fern (Polystichum capense J. Sm.) in Florida. Five percent extract of derris, 1:800 plus soap, 2 pounds to 50 gallons, gave satisfactory control. At the end of 5 hours 93.2 percent were dead and the following day 95 percent were dead. Spraying with nicotine sulfate 1:800 plus soap, 2 pounds to 50 gallons, plus 5 percent extract of derris 1:800

gave 100 percent control. Reinfestation occurred from eggs deposited before the application of the spray. Richardson (231), in a review of insecticidal research, referred to McBride's results.

Eutettix tenellus (Bak.), beet leafhopper

Chamberlin (49) in 1933 reported that preliminary tests at Twin Falls, Idaho, showed derris to be approximately as effective as pyrethrum when used in oil against the beet leafhopper.

Douglass, Wakeland, and Gillett (83) in 1939 reported on field experiments for control of E. tenellus in Idaho. In 1937 tests were made with derris (3 percent rotenone) at 4 pounds per 100 gallons plus 12.8 ounces Aresket, applied 4 times at dosages ranging from 110 to 150 gallons per acre. The insect population was decreased only after the fourth application. It was concluded that, of the materials tested, pyrethrum was the only insecticide found to be specific against the beet leafhopper.

Idiocerus sp., mango hoppers

Bhatta and Narayanan (15) in 1937 reported that at concentrations of 0.066 percent, suspensions in water of the powdered roots of Derris elliptica (harvested after 2 years' growth) resulted in 80-percent mortality of Idiocerus sp. in the field. Tephrosia candida and Mundulea sericea were ineffective at low concentrations against this pest. Suspensions of derris in water soon lost their toxicity.

Water suspensions of Derris elliptica roots (rotenone 7 percent and ether extractives 22 percent) killed mango hoppers at a concentration of 0.066 percent. Alcoholic extracts and the powdered root as a dust were also effective.--Mysore, India, Department of Agriculture (203) in 1938.

Macrosteles divisus (Uhl.), six-spotted leafhopper

The New York Agricultural Experiment Station at Cornell University (213) in 1937 reported that dusts containing sulfur, pyrethrum, and rotenone reduced the amount of lettuce yellows in experimental plots, through the control of leafhoppers which spread the disease.

Pepper and Haenseler (225) in April 1939 reported on the control of the six-spotted leafhopper, a vector of lettuce yellows. In 1936 rotenone-pyrethrum-sulfur dust and derris-talc-sulfur dust (rotenone 0.75 percent) significantly reduced the leafhopper-nymph population. Derris marc plus sulfur was ineffective. In 1937 derris plus sulfur, derris plus pyrethrum plus sulfur, and pyrethrum plus sulfur dusts gave best control of leafhopper. In 1938 tests were made with derris plus sulfur plus talc (rotenone 0.75 percent); derris plus sulfur plus talc plus Stemtox D (rotenone 0.50 percent and pyrethrins 0.0125 percent); and also with pyrethrum plus sulfur. The authors conclude that both rotenone and pyrethrum dusts give good control of the leafhopper.

Typhlocyba froggatti Bak., a canary fly

Evans (96) in 1938 reported that in Tasmania infestations of the canary fly on hawthorn hedges may be reduced with derris dusts, one application being made early in November and a second one, if warranted, at the end of January.

Typhlocyba pomaria McAtee, the white apple leafhopper

The Idaho Agricultural Experiment Station (159) in its annual report for 1932 stated that T. pomaria is an important pest of the apple in southwestern Idaho. Among the materials tested and found to be satisfactory was Cubor (pyrethrum and rotenone). Cube extract in oil emulsified in water with powdered milk (cube 1:25,000; oil 0.5 percent) killed 82 percent of the first-brood nymphs.--Turner (271) in 1932.

A dust containing 25 parts of derris (3.95 percent rotenone) and 75 parts of gypsum was ineffective in field tests.--Kelsall and Stultz (170) in 1937.

The Massachusetts Agricultural Experiment Station (195) in 1938 reported the results of tests made at Waltham to control the white apple leafhopper. In laboratory experiments with pyrethrum and cube dust all leafhoppers were killed in 24 hours. Experiments at constant temperatures showed a slight but not consistent increase in effectiveness at 80° F., but not at 60° or 70°.

Typhlocyba rosae (L.), the rose leafhopper

McDaniel (186) in 1928 wrote that among the other better-known contact sprays are Derrisol and some of the pyrethrum extracts. With these, as with nicotine, each insect must be hit in order to be killed. (Empoa) T. rosae is one of the insects controlled by these contact sprays.

Cicadellidae (unidentified species)

Hamilton (135) in 1933 reported that derris and cube powders have a distinct repellent effect and some fumigating effect against leafhoppers.

The Kentucky Agricultural Experiment Station (171) in 1934 reported that in studies with leafhoppers spray combinations containing rotenone, pyrethrum, and pine oil were more toxic than nicotine. Nicotine caused nausea among the laborers in two instances, but the combinations did not.

Derris was tested against leafhoppers but the infestation was too light to permit conclusions to be drawn.--Howard et al. (154) in 1935.

Garman (118) in 1936 reported that leafhoppers, although present in other parts of an apple orchard, were absent from the derris-sprayed plot.

The Florida Agricultural Experiment Station (105) in 1937 reported that sulfur dusts containing pyrethrum gave an immediate kill of jassids far superior to that obtained with sulfur dusts containing rotenone. However, a week after the applications were made there was little difference between the pyrethrum- and rotenone-dusted plots, though the advantage was in favor of the pyrethrum.

Cicadidae

Magicicada septendecim (L.), the periodical cicada

Cory and Knight (56) in 1937 reported that Red Arrow at a dilution of 1:400 killed 100 percent of all periodical cicadas hit. Spraying at night is preferable, as cicadas fly too actively during the day to permit of success then. Rotenone [derris?] alone (4 pounds) and with Penetrol (1/2 gallon) per 100 gallons of water gave 25-percent kill.

Coccidae

Aonidiella aurantii (Mask.), the California red scale

R.H. Smith (246) in 1929 made tests against the California red scale on lemon trees with nicotine and extracts of pyrethrum, derris, three species of Tephrosia, and two species of Lonchocarpus, in a highly refined kerosene. No combination showed any practical value.

Smith (247) in 1932 described attempts to increase the effectiveness of highly refined spray oils by incorporating toxic substances (called "toxicants") in them. Laboratory tests were made with kerosene and mineral-seal types of oil on (Chrysomphalus) Aonidiella aurantii, and orchard tests were made in which light-medium and medium spray oils were used. Among the toxicants tested in a highly refined kerosene (viscosity 30 seconds, 98 percent unsulfonatable, and applied as a mechanical mixture in water without emulsifier) were nicotine, pyrethrins, rotenone, and various extracts of pyrethrum, Derris elliptica, three species of Tephrosia, Lonchocarpus sp., and haiari. Butyl phthalate increased the solubility of rotenone in the oils. Smith concluded that the attempts to increase the effectiveness of spray oils by the use of toxicants, in the experiments with the California red scale, were unsuccessful.

Tox-X or Ortho Derris plus a reduced dosage of oil is decidedly less effective than the regular oil sprays against the red scale.--California Fruit Growers' Exchange (34) in November 1935.

In the August 1936 issue of their Pest Control Circular (35) regarding so-called nonoil sprays, the California Fruit Growers' Exchange stated that Ortho Derris and Tox-X are composed of a powdered insecticide containing derris added to a low dosage of light medium oil, usually 1/2 to 2/3 percent. At the lower dosages of oil, these derris combinations have had little effect against the red scale. They cost several cents a tree more than oil sprays. Where used with light-medium oil at strengths as high as 1-1/2 percent, the cost approximates that

of fumigation. However, in orchards where the red scale is a problem, in the light of present knowledge it would appear that these sprays, even with the higher dosages of oil, should not be substituted for the regular oil spray and fumigation program.

The Leffingwell Company in 1937, in a letter to R. C. Roark, stated that when Tox-X is used with oil it is fairly effective against the citrus red scale, and is superior to oil alone.

The California Fruit Growers' Exchange, Bureau of Pest Control (43) in November 1938 reported on the use of rotenone-oil products for the control of the red scale on citrus. The extent of red scale kill has been directly related to the amound of oil used, without regard to the addition of botanical powder. On the whole, the minimizing effects of these lower dosages of oil on water rot of Navel oranges has not been particularly pronounced. Furthermore, when more than 1 percent of oil was used with rotenone, the cost over regular-dosage oils was increased.

LaDue (179) in 1938 reported that during the winter of 1936-37 tests were made on a number of organic solvents from the standpoint of (1) the solubility of the derris resinate in the solvent: (2) the solubility of solvent in the spray oil; (3) the solubility or suspensibility of the derris resinate-solvent mixture in the spray oil; (4) the solubility of the solvent in water; and (5) the toxicity of the mixture to certain scale insects. The main groups of the solvents tested were (1) alcchols, (2) alcohol-ethers, (3) ethers, (4) glycols, (5) aldehydes, (6) ketones, (7) esters, (8) aliphatic amines, (9) chlorinated products of the saturated hydrocarbons, (10) phenols, (11) benzene and benzene derivatives, and (12) the essential oils. Only a few compounds in each group were tested. The higher ketones appeared to give the best results from the standpoint of solubility of the derris resinate, stability of the resulting mixture, and added toxicity to the spray oil. Other compounds such as 2,2'-dichlorethyl ether, sassafras oil, and the higher acetates appeared to be good solvents for derris resinate, and experimental data seem to indicate an added toxicity to the spray oil. A. aurantii was used as the test insect.

Derris resinate is not very soluble in highly refined petroleum oil such as is used in the spraying of citrus. Thus, when an appreciable amount of the derris resinate-solvent mixture is added to the oil, a suspension of resins and rotenone is formed. In the early part of 1937 laboratory experiments were made using methyl isobutyl ketone, methyl-n-amyl ketone, and 2,2'-dichlorethyl ether as intermediary solvents for the derris resinate and tank-mix spray oil. Lemons infested with the California red scale were used for the experiments. Derris resinate dissolved in methyl-n-amyl ketone appeared to give the best kill of the three solvents. Ebeling has shown that methyl-n-amyl ketone incorporated in spray oil increases the toxicity of the oil to the red scale. Further laboratory and field work by Ebeling during the summer and fall of 1937 also substantiates the above findings with regard to the toxicity of derris resinate to the red scale.

The United States Department of Agriculture, Bureau of Entomology and Plant Quarantine (283) in its 1938 annual report stated that preliminary work had been done in California looking toward the development of the use of added toxicants, including rotenone, with oils for the control of the California red scale. Butyl phthalate was found to be a satisfactory solvent for petroleum oils and certain organic toxicants. Preliminary tests were carried on with various petroleum and vegetable oils in combination with nicotine and with rotenone.

The California Fruit Growers' Exchange, Bureau of Pest Control (46) in November 1939 reported that oil-rotenone sprays at 3/4 to 1 percent of light medium oil will not control the red scale.

Ebeling (92) in 1940 reported that powdered rotenone-bearing roots give little or no increase in effectiveness of spray oil when used against the red scale, which necessitates the extraction of the rotenone and other poisonous constituents of the root and their being dissolved in the spray oil. However, derris resins increase the effectiveness of the oil, at least to some extent, if a suitable solvent is used. Such solvents includ dibutyl phthalate, 2 pints per 100 gallons of spray; Cardolite-627, 1 pint per 100 gallons; and K-58, 1/2 pint per 100 gallons. Walnut-shell flour mixed with oil-toxicant (2 percent oil plus derris, cube, and timbo resins), at the rate of 3 pounds of flour per 2 gallons of oil-toxicant per 100 gallons water, has usually resulted in substantial increases in kill. Cardolite-627 was used as a mutual solvent. The percentage survivals were as follows: Oil alone, 17.6; oil-toxicant, 7.3; and oil-toxicant-walnut-shell flour, 4.4.

Aonidiella citrina (Coq.), the yellow scale

The California Fruit Growers' Exchange, Bureau of Pest Control (41) in June 1938 stated that there has been an increase of the yellow scale in Ventura County, Calif., in the area around Santa Paula and Fillmore. The continued use of low-dosage oil-rotenone sprays may be partly responsible for this condition. The Exchange further reported (46) in November 1939 that oil-rotenone sprays at 3/4 to 1 percent of light medium oil will not control A. citrina.

Aspidiotus perniciosus Comst., the San Jose scale

Cube extract in oil emulsified in water with powdered milk (cube extract 1:12,500; 1.0 percent oil) killed 99.6 percent of the overwintering females, while the check oil killed 96.4 percent.--Turner (282) in 1932.

The Jeffingwell Company in 1937, in a letter to R. C. Roark, stated that Nox-A (2.5 percent rotenone) plus oil has given promising results and is superior to oil alone.

Aulacaspis rosae (Bouche), the rose scale

Rotenone in oil was highly effective.--Turner (271) in 1932.

Ceroplastes rubens Mask., a pink wax scale

Ishigai (163) in 1937 wrote of the use of derris in Japan, and argued that fresh derris roots are more effective than dried roots. Ground fresh roots plus soap as a spray killed 80 percent of C. rubens on persimmon and from 80 to 100 percent of various coccidae on orange and pear. On the other hand, farmers know that if the imported dried roots are used the results obtained are negligible. Something contained in the fresh crude root and lost in the dried roots appears to make the difference. This is an angle not yet studied by scholars, perhaps because of the bad smell of the fresh crude roots.

Chionaspis euonymi Comst., the euonymus scale

Rotenone in oil was highly effective in controlling this species on greenhouse plants.--Turner (271) in 1932.

Hamilton (136) in 1938 reported that cube and derris powders (4 percent rotenone and 16 to 18 percent total extractives), applied as a spray at the rate of 4 pounds per 100 gallons with the addition of 4 pounds of rosin-residue emulsion, were satisfactory as a contact poison against young scales on euonymus trees.

Haude (144) in March 1939 recommended cube or derris powder spray (4 pounds powder containing 4 percent of rotenone plus 4 pounds of rosin-residue emulsion per 100 gallons) for the control of young scales.

Chionaspis furfura (Fitch), the scurfy scale

According to Hammer (138), in 1936 results of preliminary tests against C. furfura using powdered derris root and a proprietary mixture of rotenone and pyrethrum extracts were not promising and were not tested further in 1937.

Chionaspis pinifoliae (Fitch), the pine needle scale

Rotenone in oil emulsified in water with powdered milk (rotenone 1:25,000, 1.0 percent oil) killed 100 percent of the half-grown females, as compared with 5 percent killed by check oil.--Turner (271) in 1932.

Chrysomphalus aonidum (L.), the Florida red scale

Rotenone in oil was highly effective.--Turner (271) in 1932.

LaDue (179) in 1938 reported that in the early part of 1937 laboratory experiments were made using methyl isobutyl ketone, methyl-n-amyl ketone, and 2,2'-dichlorethyl ether as intermediary solvents for the derris resinate and tank-mix spray oil. Ebeling found that the methyl-n-amyl ketone-derris-resinate solution increased the toxicity of the oil to (Aonidiella) Chrysomphalus aonidum (L.).

Coccus pseudomagnoliarum (Kuw.), the citricola scale

The California Fruit Growers' Exchange, Bureau of Pest Control (37), in September 1937 reported that fumigation tests showed the citricola scale to be resistant to hydrocyanic acid gas, as in the past. Orchards with any noticeable amount of this scale should be sprayed with light-medium oil. Growers desirous of reducing the use of oil to a minimum might well consider the derris-oil combinations.

LaDue (179) in 1938 reported that in the early part of 1937 laboratory experiments were made using methyl isobutyl ketone, methyl-n-amyl ketone, and 2,2'-dichloroethyl ether as intermediary solvents for the derris resinate and tank-mix spray oil. The derris resinate-methyl-n-amyl-ketone-oil mixture has been tested on C. pseudomagnoliarum. The results indicated an added toxicity of the oil to this insect. A paste formed by the addition of methyl-n-amyl ketone or 2,2'-dichloroethyl ether to the derris powder seemed to increase the efficiency of the material. The Exchange also reported (45, 46) in 1939 that oil-rotenone sprays at 3/4 to 1 percent of medium oil were effective for control of mixed populations of citricola scale and the black scale(Saissetia oleae (Bern.)).

Coccus viridis (Green)

Bhatta and Narayanan (15) in 1938 reported the work done in Mysore on the insecticidal value of plant fish poisons and other forest products. Alcoholic extracts of seed of Tephrosia candida, bark of Mundulea sericea (suberosa), seeds and leaves of Tephrosia villosa, and roots of Derris elliptica at a concentration of 10 percent in most cases, but much less for the seeds and derris, gave from 60- to 100-percent mortality of (Lecanium) Coccus viridis Green in 3 to 4 days, in which period the standard insecticides, nicotine sulfate, and hongay, Pongamia glabra, oil-resin soap, both at 2 percent, gave from 80- to 100-percent mortality. In small-scale field trials, extracts of seeds of Tephrosia candida and stem bark of Mundulea sericea were effective at 2- and 3- percent concentrations, respectively, against C. viridis on coffee and guava. Water suspensions and alcoholic extracts of derris (7 percent rotenone and 22 percent other extractives) were effective against Coccus (Lecanium) viridis Green.--Mysore, India, Department of Agriculture (203) in 1938.

Dactylopius sp.

Schmitt (240) in 1930 reported derris dust to be ineffective against cochineal insects.

Diaspis carueli Targ., the juniper scale

Hamilton (136) in 1938 reported cube and derris powders (4 percent rotenone and 16 to 18 percent total extractives) applied as a spray at the rate of 4 pounds per 100 gallons, with the addition of 4 pounds of rosin-residue emulsion, to be satisfactory contact poisons against young scales on juniper trees.

Spray with cube or derris powder (4 percent rotenone) at 4 pounds per 100 gallons, plus 4 pounds of rosin-residue emulsion, for the control of young scales.--Haude (144) in 1939.

Lecanium sp.

Derris or rotenone suspensions were ineffective.--DeBussy et al. (32) in 1935; also (31) in 1936.

Not affected by derris.--Van der Laan (178) in 1936; also DeBussy et al. (31).

Lepidosaphes beckii (Newm.), the purple scale

English (94) in August 1939 reported on derris as a toxic supplement to oil emulsions for the control of the purple scale on satsuma oranges. Experiments were conducted on potted plants and in the field. Emulsions prepared from several oils and emulsifying agents were used as carriers. No control attributable to derris was obtained with an 83-viscosity tank-mix oil spray as the carrier; however, derris was effective when used with a 41-viscosity tank-mix oil spray and with diglycol laurate. In experiments with potted plants derris was an effective supplement to mineral-seal oil emulsions prepared with diglycol laurate, diglycol oleate, sodium oleyl sulfate, or powdered skim milk, or with dried-blood albumen in a tank-mix spray. Although the tank-mix emulsion with derris was the most effective spray applied to potted plants, the increase in effectiveness attributable to derris was low, and positive field results were not obtained. Greater increases in kill attributable to derris were obtained with emulsions prepared from diglycol laurate, diglycol oleate, and sodium oleyl sulfate. Both derris and Derrisol, when used as supplements to a 2-percent emulsion prepared from mineral-seal oil and diglycol oleate, reduced significantly the percentage of scaly fruit on field plots. An experiment with extracted and unextracted derris showed that derris was a true toxicant to the purple scale.

Lepidosaphes ulmi (L.), the oystershell scale

McIndoo, Sievers, and Abbott (189) in 1919 reported that derris applied as a dust was of no value against the crawling young of the oystershell scale.

Orthezia insignis Dougl., the greenhouse orthezia, or lantana bug

McIndoo, Sievers, and Abbott (189) in 1919 reported that derris applied as a dust was of no value against the orthezia.

Worsley (324) in 1936 reported as follows concerning bark of Mundulea suberosa Benth. (0.9 percent rotenone) from Moa district, Tanganyika Territory, East Africa, and derris root (5.4 percent rotenone): Both derris and Mundulea bark killed 100 percent of O. insignis at a concentration of 2 percent, but a concentration of 7.5 percent nicotine was required for 100-percent kill.

Phenacoccus aceris (Sign.), a mealybug

Derris sprays were ineffective.--Patterson (221) in 1936.

Phenacoccus gossypii T. & C., the Mexican mealybug

Heiswander (204) in 1935 reported that a product containing 1 percent of rotenone at 1:200 plus Penetrol at 1:200 killed 31 percent of P. gossypii on greenhouse chrysanthemums. The best control, 91 percent, was obtained with Lethane No. 420 at 1:400 plus Penetrol at 1:200.

Richardson (232) in 1935 reported on the insecticidal control of P. gossypii on greenhouse chrysanthemums. A derris dust containing 4 percent of rotenone killed 10.5 percent of the nymphs, pupae, and adults, and 7 percent of the eggs. A derris extract diluted to contain rotenone 1:10,000 by weight plus other derris extractives was mixed with potassium-coconut-oil soap (0.33 percent dry soap by weight). This spray killed 58.5 percent of the nymphs, pupae, and adults. The same derris extract plus 0.5 percent by volume of a sulfonated petroleum oil [Penetrol?] killed 15.5 percent of the nymphs, pupae, and adults. The best control (97.3 percent) was obtained by a 10-percent emulsion of kerosene.

Pseudococcus brevipes (Ckll.), the pineapple mealybug

Watanabe (301) in 1936 reported that derris sprays have proved of some value in the control of P. brevipes on pineapples in Formosa.

Pseudococcus citri (Risso), the citrus mealybug; a greenhouse mealybug

McIndoo, Sievers, and Abbott (189) in 1919 reported that derris applied as a dust was of no value against this mealybug. Derris has given irregular and rather unsatisfactory results.--Kopp (176) in 1924.

Rotenone suspended in water (1:250) killed only 25 percent and a dust of 2 parts of rotenone and 98 parts of diatomaceous earth killed none.--Davidson (63) in 1930. Rotenone in oil was highly effective.--Turner (271) in 1932.

A rotenone-pyrethrum spray containing 0.75 percent of rotenone and 1.8 percent of pyrethrins at 1:200 reduced the infestation 74 percent, as compared with a 99-percent reduction obtained by Lethane No. 420 at 1:800 plus soap 1:250. Three applications were made at intervals of 1 week on these mealybugs infesting coleus.--Heiswander (204) in 1935.

Pseudococcus comstocki (Kuw.), the Comstock mealybug

Rivnay (233) in July 1930 reported on the control of P. comstocki on citrus in Palestine. A proprietary insecticide containing derris and pyrethrum gave an unsatisfactory mortality; so did also another brand containing derris alone when used at the rate of 1:500, as directed by the manufacturers.

Pseudococcus sp.

Rotenone sprays were ineffective against a mealybug on parrotfeather (Myriophyllum). The rotenone suspension was prepared by adding a solution of 0.2 gm. rotenone in 5 cc. benzene and 95 cc. Penetrol to water to make a concentration of rotenone 1:100,000 plus Penetrol 1:200.--Darley (62) in 1931.

Foliafume (a pyrethrum-derris spray with spreader) at 1:400 killed 85 percent in 48 hours.--Penick and Company (233) in 1936.

Derris or rotenone suspensions were ineffective.--DeBussy et al. (32) in 1935, (31) in 1936.

Not affected by derris.--Van der Laan (178) in 1933; DeBussy et al. (31)

Pulvinaria vitis (L.), the cottony maple scale

Hamilton (136) in 1938 reported cube and derris powders (4 percent rotenone and 16 to 18 percent total extractives) applied as a spray at the rate of 4 pounds per 100 gallons with the addition of 4 pounds of rosin-residue emulsion to be a fair contact poison against this insect on maple trees. Nicotine is better.

Saissetia hemisphaerica (Targ.), the hemispherical scale

Rotenone in oil was highly effective.--Turner (271) in 1932.

Saissetia oleae (Bern.), the black scale

The Bureau of Pest Control of the California Fruit Growers' Exchange, in the November 1935 issue of their Pest Control Circular (34) reported results of tests with new citrus sprays against uniformly small black scales, as follows:

Material and dosage	Amount of oil added	Average mortality
		Percent
Ortho Derris, 4-5 lb. per 100 gal.	0.5 pct. light-medium to 0.67 pct. medium	99.06
Regular oil spray	1.67 pct. soluble or 2 pct. emulsion	99.7

Ortho Derris, sold by the California Spray Chemical Company, was the most widely used spray of the nonoil materials during the regular black scale season. A considerable number of groves were treated with satisfactory results; although, as shown in the last column of the table, it was somewhat less effective than the regular oil sprays. To date no injury by this spray has been observed on either green or ripe fruit, or on foliage. Tox-X (2.1 percent rotenone) at 1 pound per 100 gallons plus 0.5 to 0.37 percent light-medium or medium oil killed 99.1 percent of small black scale. Against black scale Tox-X was equal to Ortho Derris but not quite so effective as regular oil sprays.

In the August 1936 issue of Pest Control Circular (35) regarding so-called nonoil sprays, it is stated that Ortho Derris and Tox-X are composed of a powdered insecticide containing derris added to a low dosage of light medium oil, usually 0.5 to 0.67 percent. Largely used in the

cooler coastal areas, these sprays gave satisfactory commercial results against immature black scales, being only slightly less effective than the commercially used black scale oil sprays at ordinary dosages. At slightly higher oil dosages, up to 1 or 1.25 percent, off-hatch scales were effectively killed in a number of orchards. The particular advantage of these sprays for the black scale at that time was that they appeared to be safer for use on mature Valencia fruit than straight oil sprays, produced less oil effect on the tree, and also checked aphids, if present. To date, derris sprays with 0.5 percent of light medium oil have shown little oil deposit, no interference with color, and ability to control the black scale satisfactorily.

The California Fruit Growers' Exchange, Bureau of Pest Control (36, 38, 42, 43, 44, 45, 46), in August 1937 stated that in Ventura County, Calif., the limited resistant black scale area in Bardsdale and Ojai may be handled by one of the derris-oil sprays, with fewer adverse effects than the regular oil sprays. Also where it is impossible to fumigate overripe fruit without serious damage the derris-oil sprays might be used. The Exchange in February 1938 recommended oil-rotenone combinations for combating the black scale associated with the red spider and the citrus aphid. A suitable spray is made from 0.5 to 0.75 gallon of light medium oil, 1 to 4 pounds of rotenone powder, and water to make 100 gallons. In July 1938 growers of oranges in Ventura County were advised that low-dosage derris-oil will handle the black scale and is easier on the trees and fruit, and in 1938 it was reported that oil-rotenone sprays had shown definite value not only in killing small black scales but, in off-season work, in destroying larger scales than did emulsions or emulsibles with the same amount of oil. The Exchange stated that in September 1939 light medium oil, medium oil, rotenone-oil sprays, and fumigation were methods largely used for control of S. oleae, according to the district; and in November 1939 the Exchange reported that oil-rotenone sprays at 0.75 to 1.0 percent of light medium oil are effective for mixed populations of the citricola and black scales. Oil-rotenone spray was more effective on advanced black scales than was miscible oil and lime-sulfur and is less likely to retard coloration than straight oil.

When used with oil, Tor-X is very effective against citrus black scale and is superior to oil alone, according to Leffingwell Company in a letter to R. C. Roark in 1937.

Boyce and Prendergast (19) in 1938 wrote that the oil-rotenone mixtures are relatively expensive when considered for the control of red spider alone. However, when considered for the combined control of aphids, red spider, and off-hatch black scale during the spring, they are very practical

LaDue (179) in 1938 reported that pastes of derris with various organic solvents added to oil sprays gave unsatisfactory results against S. oleae on Washington navel orange trees. Acetone and ethyl ether-derris extracts were also used with low percentages of spray oil, but certain difficulties were encountered, such as the resins flocculating and going out of the oil phase into the aqueous phase. In the early part of 1937 laboratory experiments were made using methyl isobutyl ketone, methyl-n-amyl ketone, and 2,2'-dichlorethyl ether as intermediary solvents

for the derris resinate and tank-mix spray oil. The derris resinate-methyl-n-amyl-ketone-oil mixture has been tested on the black scale and the results indicate an added toxicity of the oil to this insect. A paste formed by the addition of methyl-n-amyl ketone or 2,2'-dichlorethyl ether to the derris powder seemed to increase the efficiency of the material.

Ebeling (92) in 1940 reported that powdered rotenone-bearing roots have been used in California for a number of years to increase the effectiveness of spray oil against the black scale. They have often made possible a reduction of oil dosage from the usual 1.5-1.67 percent to 1 percent or less.

Coccidae (unidentified species)

Coccidae in general are not affected by derris.--Van der Laan (172) in 1936.

Van der Vecht (287) in 1933 reported that experiments with derris against Coccidae had so far failed to give satisfactory results.

From 80 to 100 percent of various Coccidae on orange and pear were killed by the application of ground fresh derris roots plus soap as a spray.--Ishigai (163) in 1937.

Mealybugs

Corbett (52), entomologist for the Federated Malay States Department of Agriculture, reported in 1930 that tuba used at the rate of 1 pound to 10 imperial gallons of water is a good insecticide for general use in the garden, as plants regularly sprayed with it will be kept comparatively free from mealybugs. Maidenhair fern and similar plants are often dwarfed in growth by mealybugs; a tuba spray would be found very satisfactory in controlling them.

Jones and Davidson (164) in 1931 reported that rotenone and derris extracts prepared with fish oil have a high toxicity to mealybugs.

Davis (36) in 1932 wrote that with penetrating miscible oils derris has proved very effective against mealy bugs.

The Rubber Service Laboratories Company, a subsidiary of the Monsanto Chemical Company (238) in 1935 reported that a spray containing 7 parts of derris resins, 33 parts of dry Aresco, and 60 parts of pine oil (or oleic acid) is effective against mealybugs at 1:200. The following mixture at 1:200 was found to be effective: Derris-resin 7 parts by weight, dry Areskap 33 parts, and either pine oil or oleic acid 60 parts.

A Method of Testing Oil Insecticides

R. H. Smith (248) in 1938 described a microtechnique method of testing oil insecticides on scale insects. This involves placing the oil directly into the spiracle of the insect, or upon any desired part of the body, and determining the effect by observation under the microscope. The method has been employed with particular satisfaction in studies with highly refined oils fortified by the addition of pyrethrum, rotenone, and other substances to make the oils toxic. Its usefulness can probably be enlarged through the use of micromanipulating apparatus of the type employed in the field of biology.

Fulgoridae

Sogata furcifera (Horv.)

Spraying with derris effected complete control of this insect attacking padi (rice) in the Federated Malay States.--Federated Malay States Department of Agriculture (190) in 1937.

Membracidae

Ceresa bubalus (F.), the buffalo treehopper

A dust containing 25 parts of derris (5.95 percent rotenone) and 75 parts of gypsum was ineffective.--Kelsall and Stultz (170) in 1937.

Glossorotus crataegi (Fh.), a treehopper

Hutson (158) in 1934 reported that nicotine, derris, and pyrethrum dusts had no effect on adult treehoppers, G. crataegi, on plum and apple.

Stictocephala festina (Say), the three-cornered alfalfa hopper

Cassidy and Barber, of the Division of Cotton Insect Investigations, Bureau of Entomology and Plant Quarantine, in 1935 reported that cube dust gave 80 percent control, derris dust (4 percent rotenone) 55 percent control, and pyrethrum 35 percent control of this insect on cotton in Arizona. Tests were made in cages in the field and also in lantern globes in the insectary. These results were cited by Loark (234) in 1936 in comparing the insecticidal value of derris and cube.

Membracidae (unidentified species)

Bhatta and Narayanan (15) in 1937 reported the work done in Mysore, India, on the insecticidal value of plant fish poisons and other forest products and stated that an alcoholic extract of the seeds of Tephrosia candida, at 1 percent concentration, controlled adults and nymphs of membracids on Cajanus indicus.

Psyllidae

Paratrioza cockerelli (Sulc), the potato psyllid, or tomato psyllid

The New Mexico Agricultural Experiment Station (208) in 1934 recorded the results of spraying experiments for control of the potato psyllid in the field. Comparisons were made of bordeaux sprays, bordeaux-oil-nicotine sprays, and bordeaux-rotenone sprays. Irish Cobbler potatoes grown at Bluewater, N. Mex., were treated with the acid-mercury dip and planted on the horticultural and Stith Farms on February 27, 1933. One section of the potatoes at the Horticultural Farm was sprayed three times with a 5-5-50 bordeaux mixture, another with bordeaux mixture containing 1 gallon of Volck oil and 1 pint of nicotine sulfate to each 100 gallons of spray material, and the third plot with a 5-5-50 bordeaux mixture to which had been added 1 pint of rotenone extract. The potatoes on the Stith Farm were sprayed with oil-nicotine and the bordeaux-oil-nicotine. There was a very noticeable difference in the yield between the sprayed and unsprayed sections, as shown by the following data:

Treatment	Yield of potatoes per acre		
	No. 1 grade	No. 2 grade	Cull
	Pounds	Pounds	Pounds
Bordeaux only- - - - - - - -	1,413	919	377
Check, not sprayed - - - - -	1,063	392	188
Bordeaux, oil, and nicotine-	2,478	1,219	513
Check, not sprayed - - - - -	1,679	1,002	229
Bordeaux and rotenone- - - -	2,033	1,161	648
Check, not sprayed - - - - -	2,112	1,160	576

Psylla pyricola Foerst., the pear psylla

Neoton (derris extract in fish oil), 150 gm. plus twice its weight of soap in 40 imperial gallons water, killed 100 percent.--Institute Physical and Chemical Research (162) in 1927.

Van Duren (286), in answer to questions sent in by growers at the New York Horticultural Society Annual Meeting in 1928, stated that Derrisol was effective for the control of pear psylla.

Hartzell (143) in 1930 reported that when a commercial pear orchard infested with nymphs of the five instars of the pear psylla was sprayed by means of a large spray rig maintaining 350 pounds pressure, Derrisol 1:533 alone was not very effective (50 percent killed) but the addition of bordeaux brought the killing efficiency equal (92 percent killed) to that of the regular spray, which consists of 2 pounds of copper sulfate, 40 pounds of hydrated lime, and 1 pint of nicotine sulfate to 100 gallons of water.

Trees were treated with a dust containing 25 parts of derris (3.95 percent rotenone) and 75 parts of gypsum. Most of the adults flew away and escaped at the time of dusting and most of those that did fall recovered later. Nymphs were very slow in dropping and but few had dropped at the end of 24 hours. Two weeks after treatment the derris-treated trees were practically free from nymphs, which were still abundant on check trees.--Melsall and Stultz (170) in 1937.

Psylla sp.

Carles (47) in 1926 reported that Psylla is one of the chief insect pests that can be easily exterminated by the application of insecticides containing derris or its products.

An anonymous writer (2) in 1930 reported the aqueous extract of derris root to be effective against psyllids.

Worsley (324) in 1936 reported concerning bark of Mundulea suberosa Berth. (0.9 percent rotenone) from Nca district, Tanganyika Territory, East Africa, and derris root (5.4 percent rotenone), that the following concentrations are required to kill 100 percent of a species of Psylla infesting citrus in Amani: 0.45 percent of Mundulea bark, 0.35 percent of derris root, and 0.25 percent of nicotine.

Psyllids on pear trees were killed by a proprietary dust containing 12 percent of cube of 6 percent rotenone content, according to a letter to R. C. Roark from Etablissements Rotenia in 1938.

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